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The Paris Conference

We attended the 23rd congress of the *Association Technique de Fonderie*, and, having participated in so many, we especially appreciate the great progress this body has made. Obviously, we are unaware as to whether the *Association* has acquired in France a reputation for the high level it has attained in the organisation of its conferences as has the Institute of British Foundrymen in this country, but we can avow that it richly merits it. There was some gossip in Paris as to whether the meeting place should sometimes be transferred to the provinces. Yet, Paris has so many real advantages, not the least of which is the fact that, being the metropolis of Continental Europe it is readily accessible to foundrymen of all countries. Last week, for instance, there were visitors from Switzerland and Portugal, and *mirabile dictu*, the banquet was graced by the presence of Mr. Wallis, the President of the American Foundrymen's Society. This is the first time—international gatherings apart—that an American president has been present at a French national function.

Dr. Ballay, the president, deserves well of his members, for, under his leadership, solid progress has been made. He is a good clear speaker and can be relied upon to say the right thing at the right moment and, above all, to make visitors feel thoroughly at home. Moreover, he and his colleagues made excellent arrangements for the presentation of Mr. Shepherd's British Exchange Paper. A series of some 30 lantern slides had been prepared—all carrying proper French captions and indications. Finally, a really intelligent summary of the Paper had been prepared and was read by Mr. P. Rigaut.

Of the other Papers, without being invidious, we thought highly of the Paper by Mr. Gerlain on the influence of the speed of loading on the tensile test-results of cast iron. It is a subject that has been too little ventilated. Not a few of the Papers, were full of *problemes et solutions*, which somehow or other we mentally translate as "snags" and "know-how." It is only our lack of Latin logic which makes us vulgarise topics worthy of such a quasi-mathematical expression. Continued co-operation may modify the respective approaches to technology, but it will never quite eradicate the two ways of thinking.

Be that as it may, by their logical approach to the question of training for the founding industry, the French have "got places." This was clearly shown by an exhibition of prize castings made by apprentices and shown in a room adjoining the lecture hall. Additionally, Mr. Waeles, the vice-president of the *Association* and chairman of its education committee, exhibited a sound film prepared as general propaganda for the foundry industry. The film follows the same general plan as that made for the brass and bronze section of our industry. Both start with art castings, and both concentrate on close-ups. Whilst the British one has fine colour effects, the French one excels in its musical background.

We only had time to visit one foundry; it was engaged in the mass-production of all types of brass taps. The outstanding features were:—Amenities equal to the best to be found in this country; a battery of low-frequency electric-induc-

(*Continued overleaf.*)

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The Paris Conference

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tion furnaces of British make; good laboratory control for both sand and metal; the use of a particularly-fine sand for facing, and the employment of quite a high percentage of North African labour. We asked as to the efficiency of these men, and were surprised to learn of the two types, Moroccans and Algerians, one—we will not say which—was deemed infinitely superior to the other. We feel sure that the handful of British visitors—seven all told—would like to join with us in our thanks for the unbounded hospitality, courtesies and kindnesses showered upon us at the Conference.

Steel Founders to Form a Research and Development Division

The British Steel Founders' Association has long recognised the need for co-operative research to reduce manufacturing costs and improve quality and the fact that, if steelfounders are to keep ahead of all foreign competition, they must lose no time in applying any new developments which can, with advantage, be used in the steelfounding processes. The Association exists to ensure that the user of steel castings gets the best service of which the industry is capable; by establishing a Division for the purpose of organising the co-operative effort in the manufacturing field, faster progress can be made in the general development of the British steelfounding industry.

The Association's plans comprise the constitution of a separate Research and Development Division, the whole of the resources of which will, if need be, be found by its member firms. The primary object of the Division will be to provide its members with information vital to the continued improvement of productivity, and, in the first place, will concentrate on bridging the gap between established scientific knowledge and existing manufacturing processes, so that the best production technique and most suitable materials can be made known to and used by all the members.

The management and organisation of the Division is to be vested in a Director of Research and a Steering Committee comprising representatives from member firms to serve on account of their ability in one or more fields of importance to steel castings manufacture. The Division will function in a different way from other research bodies working on steelfoundry problems, although it is intended to maintain the closest possible contact with existing institutions, to ensure that no problems of importance to the industry are neglected. The fact that the Division is, at the time of its inception, assured of the support of the vast majority of those engaged in the industry, speaks well for the industry's determination to do its full share in recovering the country's position as the leading exporter of engineering products.

Forthcoming Events

OCTOBER 24.

Sheffield Society of Engineers and Metallurgists.

"Men, Machines and Management," by Sir F. Ewart Smith, at the Royal Victoria Station Hotel, Sheffield, at 6.15 p.m.

OCTOBER 25, 26 and 27.

Institute of Welding.

Autumn meeting, 1949. Tuesday, at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, at 6.30 p.m.; Wednesday, at the Institution of Civil Engineers, Great George Street, London, S.W.1, at 11 a.m.; Thursday, at the Institution of Civil Engineers, at 10.30 a.m. A works visit is included in the programme.

OCTOBER 25.

Chemical Engineering Group.

"Chemical Engineering Problems in the Sea-water Magnesia Process," by H. W. Thorpe and W. C. Gilpin, at Burlington House, Piccadilly, London, W.1, at 5.30 p.m.

OCTOBER 26.

Institute of British Foundrymen.

Birmingham Branch:—"Foundry Refractories," by Dr. J. R. Rait and Dr. Ford, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 7 p.m.

London Branch:—"The Casting of Large Pulley Wheel in Aluminium Alloy," by W. Wilson and A. Talbot, at the Waldorf Hotel, Aldwych, London, W.C.2, at 7.30 p.m.

OCTOBER 27.

Institute of Vitreous Enamellers.

Midland Section:—"Nickel Dip," by Dr. G. T. O. Martin, at the Chamber of Commerce, New Street, Birmingham, at 7.15 p.m.

Institute of British Foundrymen.

Scottish Branch:—"Modern Light Castings Production," by R. S. M. Jeffrey, B.Sc., F.R.I.C., at University College, Dundee, at 7.30 p.m.

"More than Meets the Eye"

This is the title of a documentary film covering the manufacture of taps, cocks, valves and the like in the works of Peglers, Limited, Belmont Works, Doncaster. It was shown last Monday to the technical Press and is now available for exhibition to trade associations, technical institutes, schools, and so forth. It is a 16-mm. sound film with a running time of 20 min. The shots in the recently-built mechanised foundry have been very intelligently taken and, together with those of the core shop, clearly show the processes necessary to make a casting. There is, however, much else to show—the extrusion plant, melting and casting, machining and plating. The worry producers have in trying to make an over-all story is solved in this case by starting off in an hotel bedroom, where an overseas buyer and his wife have a tiff because of his enthusiasm for business. This, like the majority of similar efforts, is somewhat puerile, and the only solution the reviewer can offer is either to cut them out or make the actors earn their money by participating throughout the film. However, the main object of the film has been well accomplished and that is, that it will convince the "man in the street" that Peglers do everything possible to ensure that the goods carrying their trade mark "Prestex" are of an exceptionally-high quality, and the reviewer congratulates the firm on its enterprise.

Work of the Lake & Elliot Foundry Technical Committee*

February, 1947, *to December*, 1948

By L. W. Sanders, C. H. Kain, R. J. Hart, W. L. Hardy and J. W. Gardom

SYNOPSIS

The Paper describes some of the work of a small technical committee set up within an iron and steel foundry. There is a discussion of the monthly examination of statistics, relating to "quality" in castings and "economics" in terms of usage of consumable materials. Details are given of researches carried out on cast-steel test-bars, following on previous work with the "cloverleaf" test bar, also the attempts made to establish a reliable and workable machineability test suitable for use by foundries.

Details are given of the development and six-months working of coated moulding sands in an iron foundry, and experience with resin-bonded core sands. Tests of martensitic plough shares are described, also a discussion of sand reclamation for the steel foundry.

Particulars are given of a critical examination of the foundry in the light of the "Report of the Joint Advisory Committee on Conditions in Ironfoundries" and the "Report of the Dust in Steel Foundries Committee."

None of the researches has yet reached finality, but it is considered that foundry research is essentially a continuous process, and hasty conclusions should be avoided.

Introduction

The foundry under the control of the Authors makes carbon steel, high-strength iron, phosphoric iron and alloy-steel sand castings, in that order of magnitude. During the period covered by this review, work has also begun upon non-ferrous die castings.

*Presented at the Annual Conference of the Institute of British Foundrymen at Cheltenham Spa.

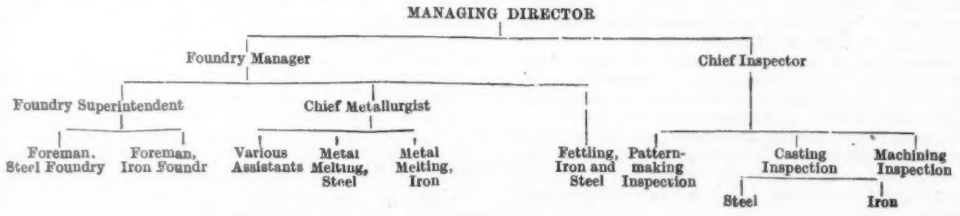
The executive administration of the foundry is somewhat as follows:—

Book-keeping and costing are divided into steel-foundry and iron-foundry accounts, but wages, purchase, progress, maintenance, etc., departments are common to both. An extensive machine shop is also a foundry department.

In the opinion of the Authors, it is a cause for regret that the various sections of the foundry industry have so far (December, 1948) failed to agree upon a common policy regarding research and technical development; or to agree upon a joint approach to the many technical problems common to all types of foundry. It was therefore decided to form a small technical committee to consider the whole field of foundry practice as carried on in the above foundry; the personnel to consist of the chief executives only, with the intention of inviting other members of the staff on an *ad hoc* basis. Mr. J. W. Gardom, M.Cons.E., A.M.I.Mech.E., F.I.M., was invited to become a member because of his long connection with the Company, his wide knowledge of the industry, and to counteract the inevitable tendency to become parochially-minded.

Meetings are held at 6.15 p.m. in the Board Room of the Company, the members preferring not to interfere with the working day. The Board Room is selected because it is felt that the discussions are of sufficient importance to warrant this dignity.

It was decided that the considerations of the Committee should be divided into five sections:—(1) Routine quality, (*a*) steel and (*b*) iron; (2) Routine economics, (*a*) steel and (*b*) iron; (3) Consideration of the work and reports of external bodies, technical Press, etc.; (4) Research and development, and (5) General.



Foundry Technical Committee Report

Since the inception of the committee in February, 1947, twenty meetings have been held, the general idea being to hold a "monthly" meeting to consider the results of the previous "month's" operations. The year is divided into 13 costing periods of 4 weeks each, and it is possible that the meetings are too frequent, but it is found that the members prefer frequent meetings. As is usual with committees, the minutes and reports are voluminous. It is thought that a précis of some of the work may be of interest as showing on a small scale the wide field of technical problems of the foundry industry.

Routine Quality

The chief inspector presents a tabulated report showing, for both iron and steel:—(*a*) The total castings fettled, *i.e.*, "finished"; (*b*) the total castings despatched, and (*c*) the total castings rejected. The rejects are analysed as follow:—(1) Scrap due to foundry defects; (2) scrap due to foundry defects but discovered in the firm's machine shops; (3) machining scrap; (4) scrap from the firm's assembly lines, and (5) customers' scrap, *i.e.*, returns.

The inspector also presents a written report discussing the causes of scrap, reporting any alteration of conditions, *i.e.*, improvement of finish or worsening of finish; any special causes for rejection, any customers complaints and a summary of inspection visits paid by himself or his staff during the previous period. Most of the information is, of course, already in the possession of the members of the committee in the normal way of works routine, but it is presented at each meeting in the form of a report suitable for committee use.

It is common experience that inspectors tend to regard inspection as an end in itself and not as a means to an end. In most foundries there are heated discussions regarding what the inspector expects and what the foundry can do. The presentation of a report of the above nature promotes free discussion and smooths out many difficulties.

There is usually a discussion on recurring troubles, some of which happen in every foundry. For instance, there is the greatest difficulty in making a brake drum with a perfectly flat back, there being a tendency for the flat disc to be undersize in thickness and to become slightly convex. The problem has been tackled from every angle, moulding equipment, pattern equipment, sand, metal, etc., but so far it has not been satisfactorily mastered. Another recurring difficulty is pinholing in small highly-polished iron castings, which occurs at most unexpected times.

Shrinkage defects underneath whirlgate and atmospheric heads on steel castings are another constant worry. It is found that a whirlgate or atmospheric head arrangement on a production line may give satisfactory results for a considerable time, but that patches of unsoundness occur from time to time underneath the connecting neck. It is felt that this type of feeder must be very sensitive to minor temperature variations.

Routine Economics

Tabulated data from the works costing department are considered at each meeting. In order to flatten out irregular variations, the data is given in the form of a moving three-monthly average. It is found that this tends to minimise any sudden variations, due to accident, but quickly shows up trends such as a tendency for the yield to decrease. The figure to which the most importance is attached is the yield of castings despatched to metal charged to the furnace, because the foundry is credited with one and debited with the other. Figures for melting loss, metal poured, metal lost in pigs and skulls, yields of castings to metal poured, etc., are also considered, but these are contributory to the main consideration.

Consumable materials—fuel, sand, refractories, compressed air, power, etc., are recorded on the basis of consumption per ton of good castings. Regular examination of these figures quickly shows unsuspected sources of waste, *e.g.*, the loss of odd bags of coaldust which have burst and been dumped. Ordinary foundry records are not sufficiently accurate as usually they are not reconciled with the financial accounts. The figures considered by the Committee are taken from purchases of goods and sales of castings. For instance, the sand consumption is recorded as tons of sand purchased for all purposes against the tons of castings sold. The data is voluminous but informative, and the Committee will be pleased to exchange information with anyone interested.

It was quickly found that the metering of compressed air is a good investment. A department was being debited with the cost of metered compressed air, but denied that they could possibly consume so much. An examination of the pipe line revealed a very small underground air leak, which when repaired reduced the overall power consumption by 15,000 k.W.H. per month. This is another argument in favour of the abolition of underground services for expensive commodities like compressed air.

The Work and Reports of External Bodies

This calls for no comment except to say that difficulty is experienced in keeping members acquainted with the growing volume of foundry literature.

RESEARCH AND DEVELOPMENT

Test Pieces for Carbon Steel Castings

A Paper* published in 1940 described the "clover leaf" form of test block for providing three test pieces of uniform physical properties. The rules governing the test block were as follows:—(1) The bars must solidify under the same freezing and feeding conditions; (2) As large an area as possible must be provided from which primary solidification can proceed, and (3) The test-pieces must be isolated from large bodies of metal which cause delayed freezing, even though these provide direct feeding influences.

The Committee decided that the next logical steps were:—(*a*) To investigate the size of test blocks or

* "Design of Test-Pieces for Carbon Steel Casting," by Kain and Dowson, *Proc. Inst. Brit. Foundrymen*, Vol. XXXIII.

test pieces which yield optimum properties, and (*b*) to investigate the possibility of providing test pieces which could properly be claimed to be representative of the casting and not merely of the steel.

Two standard test blocks poured from the same heat and heat-treated together were machined to the five sizes of test-piece specified in B.S.S. No. 18-1938. The results are shown in Table I. (In this investigation basic electric steel was used and all test pieces were given identical heat-treatment, *i.e.*, they were normalised at 920 deg. C.)

TABLE I.—*Standard Test Block Machined to Various Diameters. Heat No.* G.868.
Composition : C, 0.22 ; Si, 0.26 ; Mn, 0.79 ; S, 0.030 ; P, 0.010 per cent.

Casting size.	Machined diameter, in.	Yield point, tons per sq. in.	Max. stress, tons per sq. in.	Elongation, per cent.	Reduction in area, per cent.
(1¼ in.)	0.798	21.5	32.2	29	39
,,	0.564	23.8	31.9	32	48
,,	0.399	20.2	32.6	31	45
,,	0.226	19.9	32.5	36	62
,,	0.125	17.1	31.8	39	55

It will be observed that there is very little difference in the properties except that the ratio of yield to maximum stress is lower on the smaller-size test bars.

It was decided to repeat this test employing a test piece of larger section, the mean section of the "leaves" of the test piece being increased from 1¼ to 1⅝ in. The results shown in Table II confirm those of Table I.

TABLE II.—*Uniform (oversize) Test Block Machined to Various Diameters Heat No.* G.919.
Composition : C, 0.19 ; Si, 0.42 ; Mn, 0.78 ; S, 0.029 ; P, 0.023 per cent.

Casting size.	Machined diameter, in.	Yield point, tons per sq. in.	Max. stress, tons per sq. in.	Elongation, per cent.	Reduction in area, per cent.
(1⅝ in.)	0.798	21.6	31.9	34	49
,,	0.564	20.8	32.2	31	47
,,	0.399	20.6	32.8	31	45
,,	0.226	19.8	32.9	36	57
,,	0.125	17.1	31.8	39	54

Both these experiments showed that cast steel is not very sensitive to changes in section, provided the conditions described above are observed. It was decided to make a third test by making five test blocks of varying average section and machining test pieces from them all to the smallest diameter.

TABLE III.—*Varying (as cast) Sections Machined to Minimum Diameter Heat No.* G.861.
Composition : C, 0.24 ; Si, 0.37 ; Mn, 0.75 ; S, 0.031 ; P, 0.019 per cent.

Casting size, in.	Machined diameter, in.	Yield point, tons per sq. in.	Max. stress, tons per sq. in.	Elongation, per cent.	Reduction in area, per cent.
1⅛	0.125	17.5	32.6	30	50
1½	0.125	17.1	33.4	36	58
1¼	0.125	17.1	33.6	32	47
⅞	0.125	17.0	34.2	32	47
⅝	0.125	17.3	33.4	39	57

It will be observed that the physical properties are remarkably uniform, but that the low ratio of yield to maximum stress is characteristic of the small diameter test pieces.

In order to check the foregoing results, five further test pieces of varying section were cast. From each test block two test pieces were taken, one of varying diameter and one of the standard 0.564 in. diameter. It thus happened that on the 1¼ in. test block two 0.564 in. bars were cut, and, also, on the ⅞ in. section test piece it was not possible to obtain a 0.564 in. test bar, the largest possible size being 0.399 in. The results are shown in Table IV.

TABLE IV.—*Varying Sections Machined to Various Diameters with Standard Control Bar. Heat No.* G.1013.
Composition : C, 0.22 ; Si, 0.33 ; Mn, 0.79 ; S, 0.021 ; P, 0.020 per cent.

Section cast size, in.	Machined diameter, in.	Yield stress, tons per sq. in.	Max. stress, tons per sq. in.	Elongation, per cent.	Reduction in area, per cent.	Izod ft.-lb.
1⅛	0.798	21.50	33.28	30.75	44.10	57.3
1⅛	0.564	21.00	33.76	29.00	43.30	
1½	0.564	21.60	34.04	31.00	55.70	56.6
1½	0.564	21.60	34.00	32.00	55.70	
1¼	0.399	21.20	33.65	30.00	49.10	56.3
1¼	0.564	21.60	33.60	30.00	47.20	
⅞	0.225	21.50	33.75	40.60	61.50	56.3
⅞	0.564	21.80	34.00	31.00	53.40	
⅝	0.259	21.97	34.52	31.30	55.50	53.5
⅝	0.319	20.56	34.08	34.70	51.25	

It was thought desirable that this final check should be carried out by an independent laboratory, and the committee is greatly indebted to the British Cast Iron Research Association for carrying out the tests given in Table IV.

The above results seem to indicate that:—

(1) In the range of sections normally used for test-block purposes, satisfactory properties are obtained with all standard sizes of test bar, there being no size which yields optimum properties.

(2) The traditional belief that the removal of the minimum amount of metal from a test piece during machining yields higher properties is not correct.

(3) The ratio of yield to maximum stress in very small test pieces is low, but other physical properties are good.

(4) Provided the rules laid down in the 1940 Paper are observed, the effect of so-called "centre-line shrinkage" is reduced to negligible proportions.

In order to obtain data on the effect of the large sections which may be necessary in a test block designed to have the same section as a heavy casting, it was decided to make a "clover leaf" test bar with the "leaves" of 3 in. section. Fig. 1 shows the dimensions of this test block, which weighed 2 cwts. 3 qrs. 13 lb. (with feeder). The test block was sectioned as shown in Fig. 2.

Sections one to five were machined to the usual 0.564 in. diameter. Sections six to ten were machined

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to 0.125 in. diameter and sections 13, 14 and 15, machined to 0.798 in. dia. Sections 11 and 12 from the same "leaf" could not be machined to 0.798 in. diameter, and were machined to 0.564 in. diameter. The results are given in Table V.

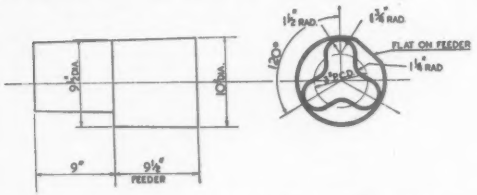

FIG. 1.—3-IN. CLOVER-LEAF TEST BLOCK; WEIGHT OF TEST BLOCK, 102 LB.; WEIGHT OF FEEDER, 219 LB.

It will be observed that bars 4, 9 and 14 which violate all three rules have inferior properties. Bars 1 and 2, 7 and 6, 11 and 12 which most fully obey all three rules are slightly better than bars 3 and 5, 8 and 10 and 13 and 15. This result indicates that

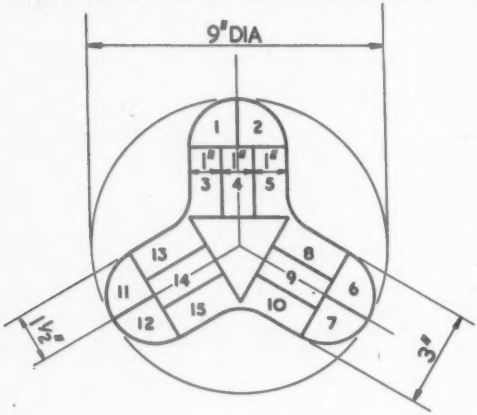

FIG. 2.—THE SECTIONING OF THE CLOVER-LEAF TEST BLOCK.

test blocks of very heavy section to represent large-section castings may be expected to yield representative properties on all sizes of test bar if the test bar be cut from a position which observes the rules previously mentioned.

Machineability of Cast Steel

Free machineability is a very desirable property in a casting. Unfortunately, the better the quality of the cast steel the greater the difficulty in machining. Most free-cutting steels contain excessive amounts of sulphur and phosphorus to make the metal brittle and cause it to break into chips which readily leave the cutting point of the tool. This type of steel cannot be considered suitable for steel castings.

TABLE V.—*Results from Large Clover-leaf. Test Block. Heat No.* G.1387.
Composition : C, 0.17 ; Si, 0.42 ; Mn, 0.78 ; S, 0.030 ; P, 0.028 per cent.

Bar No.	Yield point, tons per sq. in.	Max. stress, tons per sq. in.	Elongation, per cent.	Reduction in area, per cent.
	(*Bars machined to* 0.564 *in. dia.*)			
1	19.44	31.60	24	30.40
2	19.52	31.76	26	33.50
3	19.28	31.72	22	30.40
4	19.04	30.96	18	24.80
5	19.12	31.84	25	29.20
	(*Bars machined to* 0.125 *in. dia.*)			
6	18.80	32.80	35.00	42.00
7	18.86	33.21	27.90	37.70
8	19.27	34.03	23.80	34.40
9	18.86	32.80	28.40	45.00
10	18.80	32.80	26.50	40.00
	(*Bars machined to* 0.798 *in. dia.*)			
13	19.60	31.86	24.50	27.80
14	19.76	31.20	19.6	22.60
15	19.80	31.68	23.70	33.60
	(*Bars machined to* 0.564 *in. dia.*)			
11	19.76	31.72	28.00	37.70
12	19.56	31.76	27.00	36.40

From time to time complaints had been received from customers, particularly automobile engineers, regarding hard castings. Investigation showed that the castings were, in fact, not hard but soft, and the complaint arose from free ferrite which became plucked from the matrix and dragged under the tool point, resulting in a very poor finish of the machined surface. In some cases the plucked material fused to the point of the cutting tool, rendering it useless.

It was decided to make some attempt to investigate the machineability of the various types of carbon steel in daily production. It was felt that the drill test was not suitable for the purpose as drilling is normally not a sensitive operation, and any machine sufficiently sensitive for the purpose would be too delicate for workshop use. After consideration, it was finally decided to use a centre lathe, as this is the universal machine tool, and to carry out tests using high-speed and cemented-carbide tools.

The very large number of possible variables in a machining operation presented great difficulties. It was decided to adopt B.S.S. standard tools, in order that the shape, rake, angle, cross section, shank, etc., could be reproduced if necessary. The tools were held in position by two clamps on a very rigid tool post with a minimum of overhang. Separate tools were used for roughing and finishing. The tests were made on solid cylindrical castings 4.875 in. diameter, the casting being held in a four-jaw chuck at one end with a centre at the other. Soluble-oil coolant was flooded over the cutting tool in each case.

The results are very voluminous, many hundreds of tests having been made.

It was found that under the conditions of test and employing the B.S.S. tools mentioned:—

(1) High-speed tool steel can be used satisfactorily on low-carbon steel, but that in order to prevent plucking, low surface speed is necessary.

(2) No plucking occurs when using high-speed tool steel on medium-carbon steel castings, and the cutting speed is controlled chiefly by the effectiveness of the coolant.

(3) Cemented carbide tools can be used successfully with both low- and medium-carbon steels at very high cutting speeds; no plucking occurs on the soft steels, provided the speed is sufficiently high.

(4) The following cutting speeds are recommended for the general conditions specified:—

Flooding with a suitable coolant is recommended in every case.

It is realised that the problems of machining are vast and complex, but the information gained by the above rather rough-and-ready methods has already proved of considerable value.

Coated Moulding Sand

In November, 1947, experiments were started on resin-coated moulding sands in the grey-iron foundry. The primary object of these experiments was to eliminate coaldust. As is well known, the presence of coaldust is the most objectionable feature in grey-iron foundry sand practice, and is the cause of much of the unpleasantness associated with some iron-foundry operations. Previous efforts to eliminate coaldust have always taken the form of using a substitute, *e.g.*, oil or pitch. The present experiments are a new approach to the subject, the principle being to coat clean silica sand with resin which will:—(*a*) provide carbon to form the gaseous film associated with the use of coaldust; and (*b*) provide a suitable surface on the grain for bonding with the minimum amount of bentonite.

The most important and the most difficult operation is to obtain a satisfactory coating on the sand grains. A solution of wood resin in methylated spirits was used, and it was found that 2 per cent. of resin was necessary thoroughly to cover the sand grains. With 1 per cent. of resin the coating was hardly distinguishable. With over 2 per cent. a mass coagulation of the sand grains took place.

FIG. 3.—UNCOATED SAND, MAGNIFICATION ×25.

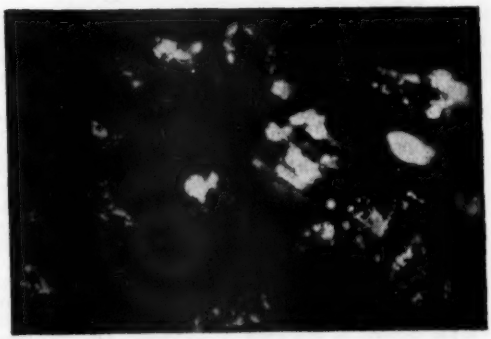

FIG. 3(*a*).—COATED SAND, MAGNIFICATION ×25.

TABLE VI.—*Recommended Speeds and Feeds.*
Butt-welded High-speed Steel Tools to B.S.S. No. 30 1¼ in. sq. by 10 in. long.

Type of steel.	Operation.	Speed surface, ft. per min.	Depth of cut, in inches	Feed in inches
Low-carbon, 0.15 to 0.20 C.	Roughing	100 to 120	⅛ to 1/16	0.016 to 0.020
Approx. 145 B.H.N. normalised	Finishing	125 to 135	0.020	0.006 to 0.010
Medium carbon, 0.25 to 0.32 C.	Roughing	80 to 100	⅛ to 1/16	0.016 to 0.020
Approx. 179 B.H.N. normalised	Finishing	100 to 120	0.010 to 0.015	0.006 to 0.010
Cemented-carbide Tools to B.S.S. 1024 1¼ in. sq. by 10 in. long.				
Low-carbon, 0.15 to 0.20 C	Roughing	275 to 300	⅛ to 1/16	0.010 to 0.015
Approx. 145 B.H.N. normalised	Finishing	300 to 350	0.015 to 0.020	0.006 to 0.010
Medium-carbon, 0.25 to 0.32	Roughing	250 to 275	⅛ to 1/16	0.010 to 0.015
Approx. 179 B.H.N. normalised	Finishing	275 to 300	0.015 to 0.020	0.006 to 0.010

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The solution was added to the dry sand in an ordinary mixer. After thoroughly mixing, the sand was passed through a rotary dryer operating at approximately 200 deg. C. to evaporate the solvent and to set the resin round the sand grains. After this operation the sand was lumpy, but after crushing in an ordinary sand mill it had no bond and was similar to dry silica sand except that it had changed colour and was dark brown. Under the microscope the sand appeared black and the grains were inclined to be of the compound type. Fig. 3 shows the un-treated and the treated sand.

In order to bond the sand for moulding, the resin coating was made slightly tacky. To do this, 0.75 per cent. of the resin solution was added to the sand during milling. When the sand and solution were thoroughly mixed, 3.5 per cent. bentonite was added with the appropriate amount of water to obtain the bond required. In the initial experiments the sand had the following grading:—

Retained on	B.S.	Sieve	No. 22	
"	"	"	30	—
"	"	"	44	16.00 per cent.
"	"	"	60	33.00 " "
"	"	"	100	35.00 " "
"	"	"	150	16.00 " "

After preparation, the moulding sand had the following properties:—Moisture, 3.00 per cent.; green compression strength, 7.31 lb.; permeability, 144, and shatter index, 62.5 per cent. It was found that this sand had truly remarkable properties. It flowed easily and rammed easily; the ramming time being less than a quarter of that required for ordinary moulding sands. It stripped well and produced castings of great accuracy; so much so, that discussions have taken place regarding the possibility of reducing machining on iron castings to a grinding allowance only. The sand was clean in working, the operators being very much less soiled and dirty than when using normal synthetic or natural moulding sand.

The rate of gas generation from the mould was very slow, several minutes elapsing before any ignition of gas could be observed. Eventually a small blue flame burned at the joint of the box. On knocking-out, a dense white smoke was given out, which rapidly dissolved in the atmosphere, leaving a faint odour similar to that of wood shavings. There was no thick black cloud of hot coaldust normally associated with the knock-out. The castings stripped easily, any adhering sand being quickly removed by wire brush. Fig. 4 shows a casting before and after brushing.

Experiments showed that castings of widely-varying sectional thickness can be made in the same sand, and castings from ¼ to 1½ in. thick were made from the same mix. Fig. 5 shows a straight-sided brake drum with a 12 in. draw weighing 1½ cwt. as cast. This type of casting is normally difficult to make true to pattern in green sand because with strong sands there is a tendency for soft places to form on the vertical walls, which permit swelling; easily-flowable sands wash and scour during pouring. It will be seen that the above casting is very clean, true to pattern and has an excellent skin. (Note the sharpness of the profile and the accuracy of the bevelled step.)

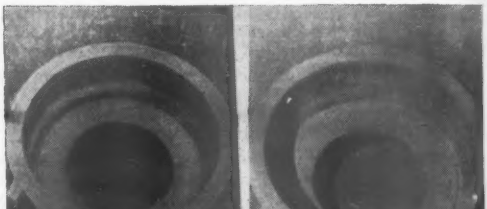

FIG. 4.—CASTING MADE IN RESIN-BONDED SAND, BEFORE AND AFTER WIRE BRUSHING.

Fig. 6 shows a valve casting weighing approximately ¼ cwt. This type of casting is usually made in naturally-bonded sand, with a strong bond and low permeability, and with about 9 per cent. of coaldust. More open-sand—with or without coaldust addition—normally produces a casting with a very poor surface

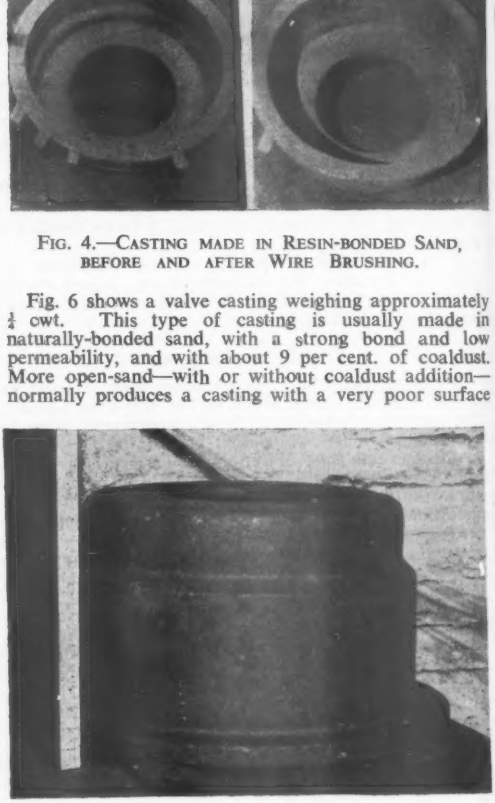

FIG. 5.—BRAKE-DRUM CASTING MOULDED IN RESIN-BONDED SAND.

finish. It will be noted that the casting shown is very clean and true to pattern, and there is entire absence of swelling in the flange radius.

The sand is very successful when used for cores. Fig. 7 shows a gearbox made with a green-sand core. The core weighed 3½ cwt. and the casting 3 cwt. The excellent finish and the accuracy are noteworthy.

At this stage it was decided to adopt the coated sand on a production line, and 15 tons of sand were processed in the manner previously described. As the castings were smaller than those previously made, a finer grade of sand was used as follows:—

Retained on	B.S.	Sieve	No. 22	—
"	"	"	30	—
"	"	"	44	—
"	"	"	60	35.00 per cent.
"	"	"	100	63.00 " "
"	"	"	150	2.00 " "

After treatment, the properties of the sand were:—Moisture, 2.5 per cent.; green compression, 6.5 to 7.5 lb. per sq. in.; permeability, 120 to 140; dry strength, 110 lb. per sq. in.; and shatter index, 65 per cent. After running for several months the permeability became reduced to 90.

Fig. 8 shows the pattern set-up for 16 in. by 13 in. boxes, and Fig. 9 a mould as it came from the machine. (Note the sharpness of the green-sand cores.) This production line ran for a period of 8 months. At the beginning it was found that the stripping was not as good as that produced in the original experiments, there being adhering sand and metal penetration in the green-sand cored holes. However, the castings cleaned perfectly in an ordinary tumbling barrel. Fig. 10 shows a casting as taken from the mould, and Fig. 11 after tumbling.

It was thought that this poor strip was associated with the presence of all-new sand. As is well known, it is usually difficult to obtain a good strip on moulds for iron castings with all-new sand, and it was hoped that, after prolonged production, the stripping quality would improve as the permeability of the sand became reduced. This hope was not realised in practice.

After investigation, it was found that the resin used in the original experiments was Scandinavian, whilst the bulk supply was American, both lots having been bought through the same official sources. The Committee were not sufficiently well versed in inorganic

FIG. 7.—GEAR-BOX CASTING FOR WHICH THE CORE WAS MADE IN RESIN-BONDED SAND.

chemistry competently to discuss the relative merits of the two types of resin. It was agreed, therefore, that Mr. Sanders should visit Sweden to discuss this

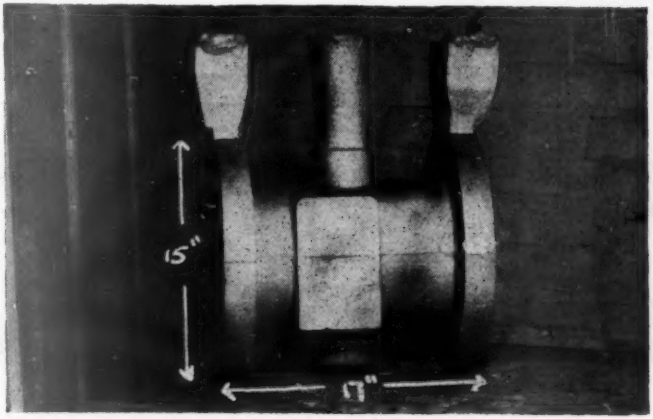

FIG. 6.—VALVE CASTING MOULDED IN RESIN-BONDED SAND.

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problem with the producers of resin. It is felt that this process has tremendous potentialities, and further work is actively proceeding.

Resin-bonded Core Sand

The need for a substitute both on economic and technical grounds for linseed oil and linseed-base core oils is well known. Many varieties of marine and petroleum oils have been used, none of them being fully satisfactory. Attention has latterly been given to synthetic resin as a bonding material, the earliest literature the Committee have been able to trace being

FIG. 8.—PATTERN ARRANGEMENT FOR THE MOULD SHOWN IN FIG. 9.

British Cast Iron Research Association Report No. 109-1934.

Both synthetic and natural resins are now available, and the Committee considered the following:—(1) Urea-formaldehyde resin; (2) phenol-formaldehyde resin; (3) natural or pine wood resin, and (4) petroleum resin. The first two resins are thermo-setting, the latter are thermo-plastic.

It was decided to eliminate thermo-plastic resins because of their low hot-strength, and urea-formaldehyde similarly because of the very disagreeable odour after pouring. Very small quantities of phenolic resin were available to the foundry industry and some difficulty was experienced in obtaining supplies. The sands available were graded as follows:—

FIG. 9.—MOULD MADE IN RESIN-BONDED SAND.

TABLE VII.—*Sands Available for Experiment with Resin-bonded Cores*

Per cent. retained on B.S. sand No.	No. 1.	No. 2.	No. 3.	No. 4.
16	—	—	—	—
22	0.20	—	—	—
30	4.90	0.10	—	0.12
44	35.80	1.90	0.20	0.14
60	29.10	29.20	0.40	2.78
100	25.95	62.05	1.20	18.58
150	3.80	5.60	62.80	36.84
200	0.30	0.60	28.80	27.28
Pan	—	0.35	3.60	6.84
Clay	—	0.20	3.30	7.36

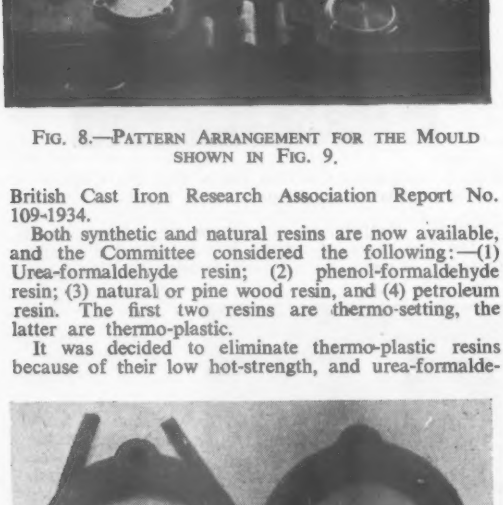

FIG. 10.—UNFETTLED IRON CASTINGS MADE FROM THE MOULD SHOWN IN FIG. 9.

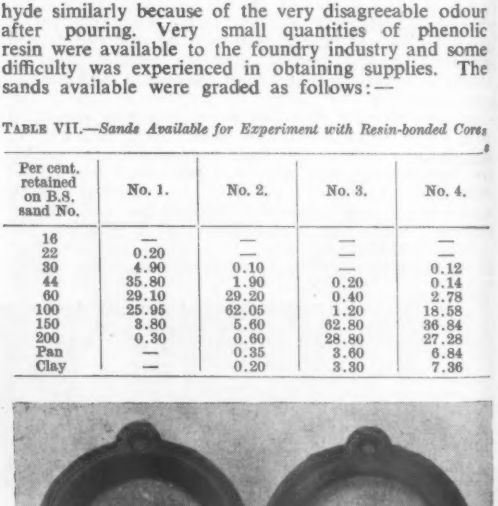

FIG. 11.—IRON CASTINGS, SHOWN IN FIG. 10, SHOWN AFTER CLEANING.

The first tentative experiment was made with half and half proportions of sands one and three, to which 1 per cent. phenolic resin, 1 per cent. of pure dextrine and 4 per cent. of water was added. From this mixture a high dry-strength and a rapid rate of cure were obtained, but green strength was almost non-existent.

TABLE VIII.—*Details of Mixtures Used for Further Experiments.*

	Mix 1.	Mix 2.	Mix 3.	Mix 4.	Mix 5.	Mix 6.
		Sand, per cent.				
Sand No. 1	50	50	50	50	50	—
2	—	—	—	—	—	100
3	50	50	—	50	50	—
4	—	—	50	—	—	—
	Bond addition, per cent.					
Dextrine (pure)	2.0	1.5	1.0	1.0	1.0	1.5
Resin ..	1.0	1.0	0.75	0.5	1.0	0.75
Fireclay ..	—	1.0	—	—	—	—
Bentonite ..	—	—	—	0.5	—	—
Silica flour ..	—	—	—	—	—	1
Sodium silicate	—	—	—	—	1·5	—

The flowability was very low, and the working properties of the sand were poor, due to the sticky nature of the mix, making removal from the corebox difficult.

Various experiments to improve the working properties, particularly the green strength, were made. Table VIII gives details of the various mixtures made.

TABLE IX.—*Properties of the Mixtures Shown in Table VIII.*

Mix No.	1.	2.	3.	4.	5.	6.
Moisture, per cent.	4.00	4.00	4.00	4.00	4.00	4.00
Green strength	1.20	2.00	2.20	2.10	2.20	1.91
Dry strength	960	650	200	400	310	520

Table IX shows the moisture content, the green strength and the dried strength of the various mixtures

It will be seen that clay (natural sand, fireclay, or bentonite) raised the green strength at the expense of dry strength. Sodium silicate and silica flour also raised the green strength with a reduction of the dried strength. Fig. 12 shows the effect of clay additions on green and dry strength.

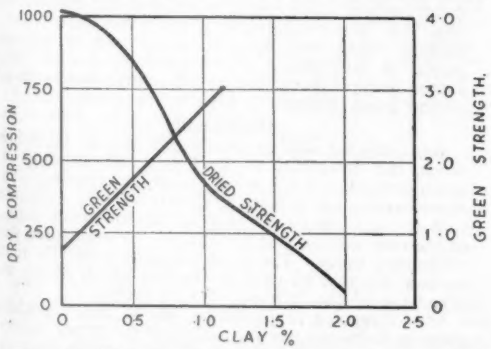

FIG. 12.—EFFECT OF CLAY ON THE GREEN AND DRIED COMPRESSION STRENGTH; MOISTURE 4 PER CENT.

The outstanding characteristics of phenolic resin-bonded core sands thus appeared to be low green strength and very high dried strength. As it was impossible to work with a green strength of less than 2 lb. per sq. in., it was found necessary to use impure dextrine, although originally it had been hoped to eliminate dextrine because of its fuming characteristics.

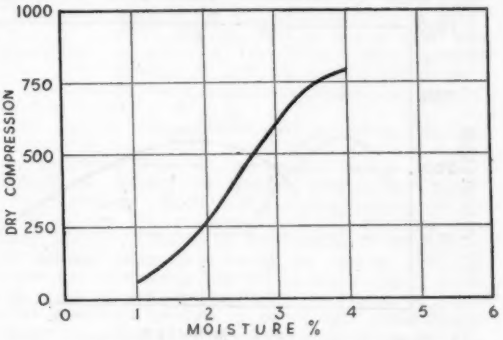

FIG. 13.—EFFECT OF MOISTURE ON THE DRY COMPRESSION STRENGTH OF THE SAND.

Fig. 13 shows the effect of moisture on the dry-compression strength in a 1.5 per cent. cereal and 0.75 per cent. resin bonded mix. Fig. 14 shows the effect of moisture on the green strength of mixes, using pure and modified dextrine. The use of the modified dextrine was very reluctantly adopted because

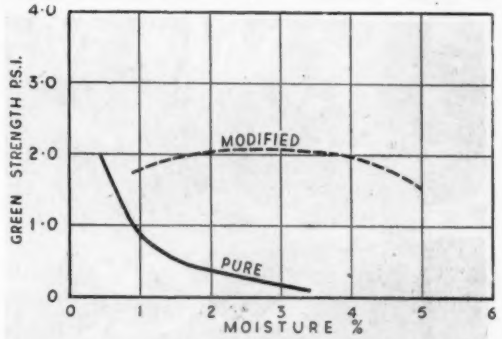

FIG. 14.—EFFECT OF MOISTURE ON THE GREEN COMPRESSION STRENGTH OF PURE AND MODIFIED DEXTRINE MIXTURES, USING 1.5 DEXTRINE AND 0.75 PER CENT. RESIN.

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this type creates much more fume than the pure variety. To overcome the inherent stickiness of resin-bonded core sands, the coreboxes were sprayed with a soft-soap solution which proved very successful.

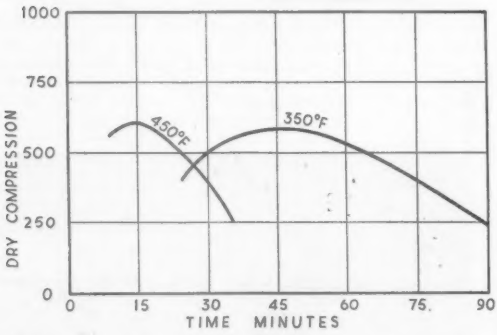


FIG. 15.—EFFECT OF BAKING TIME AND TEMPERATURE ON THE DRY COMPRESSION STRENGTH; 1.5 DEXTRINE AND 0.75 PER CENT. RESIN MIXTURE.

Production started with a sand containing:— Moisture 2.5, impure dextrine 1.5, resin 0.5 per cent. This sand had a green strength of 1.95 lb. per sq. in. and fair working qualities. The cores were baked at 400 deg. F. (200 deg. C.) in a continuous oven, but it was quickly found that many of the cores were friable on the surface, having a scratch hardness of only 45 to 50 with a dry-compression strength of 500 to 550 lb. per sq. in. As the cores were made and fed to the oven on a continuous conveyor, a check was made on the air drying of the cores before baking, with the following results:—

Condition	Strength	Scratch hardness
Straight into oven	600	85 to 90
5 mins. air drying	520	75 to 80
10 mins. air drying	435	60 to 70
15 mins. air drying	270	45 to 50

This proved that the surface friability and loss of strength was due to loss of moisture to atmosphere. Friability has been overcome by spraying the cores in the green state with a solution of resin and water. Fig. 15 shows the effect of baking time and temperature.

Fig. 16 shows a number of resin-bonded cores on a steel band conveyor.

FIG. 16.—RESIN-BONDED CORES BEING CONVEYED TO THE OVEN.

Collapsibility and Fuming

The collapsibility of resin-bonded cores is better than

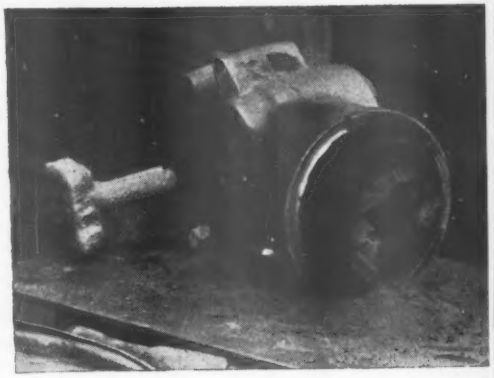


FIG. 17.—IRON CASTING AT THE KNOCK-OUT, SHOWING THE COLLAPSIBILITY OF RESIN-BONDED CORES.

oil-bonded cores; cores where there is a heavy core-to-metal section ratio break down without trouble (see Fig. 17). The fuming is very much less than with oil binders, being very light in nature and rapidly dispersed to atmosphere. Unfortunately, dextrine itself causes heavy fuming and an alternative means of obtaining green strength is urgently necessary.

Mouldability

Resin-bonded sand is totally different to oil-bonded sands, the flowability is much less and although the green strength is low it is very tough in ramming. This necessitates more ramming, similar to that associated with the old-fashioned naturally-bonded sands instead of the easy ramming or tucking usually associated with oil-bonded sands. The hard ramming naturally tends to slow the rate of core production which offsets the advantage of the increased baking speed.

The foregoing experiments show that synthetic phenolic resins are not yet perfect or foolproof as core-binders, but it is the belief of the Authors that the difficulties are not impossible of solution.

(To be continued.)

Mr. F. Arnold Wilson's Presidential Address

Institute's Activities Outlined to the London Branch

At the opening meeting of the Autumn session of the London Branch of the Institute of British Foundrymen, Mr. F. Arnold Wilson delivered his inaugural address. Realising, from his long experience as honorary secretary of the branch, that a large number of the newer and younger members knew but little about the Institute, he reviewed for their benefit its structure, organisation and activities. He then dealt with the National Foundry College, as he knew from his experience that too few foundrymen were familiar with its need and potentialities. In the course of his address he said:—

The foundry industry was responsible for maintaining a much bigger proportion of the people of this country than was commonly supposed, and during the past twenty-five years it had been lifted from a comparatively simple craft to one on a highly technical basis. The result of this was that the men who expected to reach the executive levels in the industry had to know a great deal more than they did. Unfortunately, a comparatively small number of well-educated men, including university men, entered the industry from outside. Therefore, the industry had to look to the development of its own "raw material" for its future leaders.

The National Foundry College (opened in 1948) had on its governing body representatives from no fewer than eleven organisations concerned with the foundry industry, including the Institute.

The original Diploma Course was designed to last about ten months full time and the standard of entry was roughly equivalent to that of Higher National Certificate in engineering, chemistry or metallurgy, which an earnest student could reach in a comparatively short time through many technical colleges. Graduates in engineering, chemistry or metallurgy, of course, were also accepted, provided they had the requisite amount of practical experience, which the College did not attempt to teach and which could only be obtained first-hand in a foundry.

Time had shown that many who would like to take the Diploma Course were, in fact, not fitted to do so by lack of previous education. The ordinary City and Guilds' certificates in patternmaking and foundry work were not quite adequate, as the syllabus did not include the right kind of preparation for a course involving foundry metallurgy, foundry engineering, foundry technology and foundry management, to the highest standard which could be taught in the country which was a standard higher than, and different from that of any other institution available. For this reason, a preliminary course had been introduced, of six months duration, designed to fit candidates for the Diploma Course. The preliminary course was known as Part I and the Diploma Course as Part II. Both courses started at the same time towards the end of September in each year, but as Part I lasted only six months, a candidate who passed through it had six months for further practical experience before he began the next session of Part II.

The course was scientific and technical, but not academic in the ordinary sense. A visit to a foundry was paid each week and an annual visit to another part of the country, or another country, was made in each session. There was a staff consisting of the Head of the College and three fully-qualified lecturers and, in addition, the best specialists throughout the industry from all parts of the country provided each year something like 80 lectures. Apart from this much of the time available was spent on practical problems relating to what are conveniently known as projects, covering methods of mould preparation and production, melting, casting, finishing and cost estimating for a given casting or group of castings, starting from the blue-print stage, including patternmaking. A major part of the Diploma examination consisted in the proper treatment of problems of this kind, which a competent foundry manager had to face every day.

Student Requirements

Obviously, the College could never be large in numbers, as the field was too highly specialised, but students could live together in the College hostel which had now been opened, and enjoy the benefits of close contact in a community life. They also shared the amenities of the well-equipped Technical College at Wolverhampton.

The number of foundries in Great Britain was about 3,000, while the number of foundries which were large enough to be technically controlled was probably about 500. In the ironfounding industry 300 foundries produce about three-quarters of the output and, if steel and non-ferrous castings were included, something like 500 would thus be a fair figure. The annual wastage of the higher executives from these 500 foundries was, of course, not known, but it could be scarcely less on age alone than 25 per annum. If one accepted this figure then it could be said with confidence that the numbers presently attending the Foundry College would not meet the annual wastage since a number of students each year came from overseas. It should be realised in these foundries that the kind of training the College had to offer could be given not only to the manager, but also to other men employed in a technical or executive capacity. It would appear that the number of men who require the kind of education the College can offer should be of the order of 2,000. If that number was to be trained in a reasonable time,

Mr. F. A. Wilson's Presidential Address

say 10 years, the present intake to the course through the industry could be multiplied by 10 without any serious problem arising, since the fact that men were sent by their employers meant that there was no problem of absorption afterwards; the men returned to their own employers. As, however, some foundries were too small to send and maintain a man for a year, in spite of the fact that the fee was remitted to founders belonging to an organised employers' federation which supported the college. a certain number of scholarships had now been provided by the governing body.

The founding industry was building up a complete organisation for its research and educational requirements, but it was imperative that the industry should take advantage of the facilities available to it so that, within the next few years, foundrymen might take the fullest advantage of modern knowledge in their products and thereby help to maintain this country's relatively high standard of living.

Vote of Thanks

Mr. R. B. Templeton (past-president of the Institute and of the London Branch), in proposing a vote of thanks to Mr. Wilson for his address, said there were many who had not previously heard a statement of how the Council and various committees of the Institute functioned. Particularly, the newer members would welcome the detailed account which had just been given.

MR. V. C. FAULKNER (also a past-president of the Institute and of the London Branch), who seconded, recalled that last year, when he was acting as question-master at a "Brains Trust" at Lincoln, someone had asked whether it would not be a good idea to have pattern colours standardised. Inasmuch as there was a British Standard existing to cover that particular matter, the question had come as something of a shock to him. However, it had served to emphasise the need for information such as Mr. Wilson had given concerning work performed on behalf of the industry, and with which the Institute was associated.

(The vote of thanks was accorded with acclamation, and Wilson briefly responded.)

Latest Foundry Statistics

According to the September Bulletin of the British Iron and Steel Federation, there was a slight increase in the average number of people (145,603) engaged in ironfounding during the week ending August 6 as compared with a month earlier. The actual rise was 69, but this must have been mainly female labour, as there was a loss of 61 in male labour. The same source shows that at an average employment level of 18,802, the steelfoundry industry decreased its operative staff by 281, of whom 272 were males. However, the average weekly output of liquid steel for steel castings during August was 7,800 tons, as compared with 6,500 tons during July and 7,500 tons a year ago.

Publication Received

Education and Training in the Steel Industry. Published by the British Iron and Steel Federation, Steel House, Tothill Street, London, S.W.1..

This report is of the first industry-wide training conference to be held in the steel industry. At Ashorne Hill nearly 100 directors, managers, training officers, and other officials of steel companies met together to thrash out some of the practical problems involved in implementing the recommendations of the comprehensive training scheme prepared by the British Iron and Steel Federation's Recruitment and Training Committee. In an industry as complex, as widely scattered and as varied as that dealing with steel, the basic principles of good training (set out in the "Sample Training Scheme" appendix to the report) are sometimes difficult to apply. The conference therefore maintained throughout a severely practical note.

First, were discussed the plans for getting all firms in the industry to set-up or participate in suitable training schemes in the various regions. Lectures were then given by the firm's training officers experienced in all aspects of works training. The problems of training the junior operative, the craft apprentice, the clerk and the technical apprentice, were dealt with by training officers from Samuel Fox, Limited, Stewarts and Lloyds, the United Steel Companies, and Richard Thomas & Baldwin's. After each lecture there followed lively and often critical discussions. Finally, it was shown how even small firms could give effect to the principles contained in the Sample Training Scheme. In all lectures it was stressed that training should be as broad as possible—to teach the young steel-worker not one but many skills, and to give him a wider understanding of the relationship between his job and the rest of the industry and between the industry and the community at large.

Castor and Rape Oils

The Ministry of Food announces that the following changes will be made in the arrangements for the supply of crude and processed castor and rape oils:—

(1) Buyers of crude castor and rape oils should apply direct to the Hull or London branches of the National Association of United Kingdom Oil & Oilseeds Brokers, Limited, for supplies needed after November 5. The Association will then issue contracts on behalf of the Ministry at the official prices ruling at the time the contract is made.

(2) The Ministry will discontinue the issue of supply orders for processed castor and rape oils for delivery after November 5, and buyers of these oils should apply direct to processors for supplies needed after that date.

DEVALUATION WOULD LEAD to a drop in imports of finished steel and this, in due course, would be reflected in Britain's overall steel supplies and her capacity to meet total home and export requirements, said Mr. J. A. Dorrat, speaking after his installation as the chairman of the North-East branch of the Institute of Welding.

Guide to Aluminium Founding I

Aluminium Alloys—Their Composition and Properties

*By A. W. Brace**

This article is the first of a special series covering alloys, melting equipment, melting techniques, moulding and core-making. The remaining articles in the series will be published at fortnightly intervals.

One of the outstanding features of the post-war foundry world has been the great expansion of the production of aluminium-alloy castings. The output for the year immediately preceding the outbreak of war was approximately 12,000 tons, but for 1948 the annual output was 48,680 tons. The lightness of aluminium alloys, coupled with a facility for large production outputs by machine moulding or cheap, accurate die-casting makes them very attractive. The high machining speeds obtainable are an important factor in reducing final costs and, in many instances, despite higher cost of aluminium, light-alloy castings can compete on purely economic grounds with cast iron. There are also a number of special applications where they show advantages in the long run, even when initial cost is higher.

There are many ways of introducing the reader to aluminium alloys, one of the popular methods being to group them arbitrarily according to their physical properties into low-, medium- and high-strength alloys. This method, although useful to the engineer and designer, will not be as readily appreciated by the practical foundryman as that of classifying them according to their main alloying constituents. The ironfoundryman is familiar with cast iron as an alloy essentially of iron with carbon, silicon and manganese, with sulphur and phosphorus present as impurities desirable or otherwise. For special purposes, nickel, chromium and copper may be added. Suitable variations in the amount of these elements present can produce cast irons with a wide range of properties. Similarly, the brass and bronze founder can produce a number of alloys by using additions of tin, zinc, lead, etc., to copper. In the aluminium foundry, the situation is rather more complex, since about ten alloying elements are in common use, and some alloys contain about six additions, each one filling a definite role. Elements used include copper, magnesium, silicon, iron, nickel, zinc, manganese, titanium, niobium and chromium. In addition, heat-treatment is applied more widely than in the ironfoundry to modify the properties conferred on the material.

Cupola operators are faced with the frequent necessity of making calculations as to the proportions of various pigs and scrap which are required to produce the required composition. On the contrary, aluminium alloys are supplied to the required analysis, and alloying of ingots is not an operation to be carried out other than by the specialist. Occasionally, small additions of the more volatile metals may be required to compensate for melting losses. In such an event a carefully weighed quantity of the warm metal should be immersed in the bath of molten aluminium with an iron plunger.

*The Author is on the staff of the Aluminium Development Association.

Main Grouping by Elements

Aluminium casting alloys may be divided into aluminium-copper, aluminium-silicon, aluminium-magnesium, aluminium-zinc and complex alloys, this grouping indicating the main alloying element (see Table I). Copper is one of the most widely used alloying additions. It produces a gradual increase in the hardness of alloys up to 14 per cent. Cu but, at approximately 4.5 per cent. Cu, gives maximum strength in this series when heat-treated. Alloys up to 13 per cent. Cu are used, particularly where hardness is required. An alloy consisting essentially of aluminium with 4 to 5 per cent. Cu gives a tensile strength of up to 18 tons per sq. in. (AC.11B)† after heat-treatment—a very high figure for cast material. Other alloys containing copper as a major constituent include B.S.S. 4L.11 and 3L.8 (7 and 12 per cent. Cu), these having been widely employed during the 1914-18 period. Two alloys produced mainly from scrap sources, AC.1 (7 per cent. Cu) and AC.12 (10 per cent. Cu), containing small amounts of zinc, silicon and other impurities, have largely replaced them. Copper is used in complex alloys because amounts of 2 to 3 per cent. in combination with other metals give improved properties after heat-treatment, due to the age-hardening properties conferred.

Silicon can be added to aluminium in amounts up to 14 per cent., and it is most widely used as Alpax (AC.6), which contains 13 per cent. silicon. All silicon alloys are characterised by good running properties which are retained in the presence of other alloying additions. The addition of magnesium to 13 per cent. Si alloy makes it heat-treatable (AC.9A and B). The addition of nickel produces a material (AC.13) with low coefficient of expansion and suitable for pistons. An alloy prepared from re-melted scrap contaminated by other alloys (AC.2) is used for pressure die-castings. A further composition used successfully for marine work is AW.8, which is, essentially, 5 per cent. Si, ¼ per cent. Mg; this is subject to heat-treatment.

Discovery of Alpax

It is interesting to note in passing that the discovery which led to the widespread use of Alpax[1] was made in

†These refer to alloys covered by the BS/STA 7 Services Schedule of Non-ferrous Metals and Alloys, Group 6, of the British Standards Institution.

Guide to Aluminium Founding I

1921 by an American, Al Pacz, who found that it was possible to improve the mechanical properties of the material by as much as 25 per cent. after treatment with an alkali fluoride flux. In the following year the use of metallic sodium to produce a similar result, with a change in the structure known as "modification," was also patented.[2] Since this period both methods have been used for production of castings in this material.

Magnesium is an element which has a very important effect on aluminium. It is added in amounts ranging from 0.05 to 13 per cent., the percentages at the lower end of the scale being to influence the response to heat-treatment of various alloys usually containing, essentially, copper and silicon. The main alloys with magnesium are AC.5 (4 per cent. Mg)[3] and AC.10 (10 per cent. Mg), both of which are very resistant to marine corrosion. The latter alloy, however, requires a heat-treatment to develop its maximum properties, and presents problems in foundry technique owing to ready susceptibility to oxidation. Zinc has also been used as a major alloying element, but does not find favour because of hot-shortness and tendency to intercrystalline cracking in service. The original alloys of this type were 3L5 and L28, but the only alloy marketed at present is AC.3 (11 per cent. Zn, 3 per cent. Cu).

TABLE I.—*Aluminium Casting Alloys.*

Alloy type.	STA/7 schedule.	Specifications.	Mechanical properties. Tons per sq. in.	Mechanical properties. Elongation, per cent.	Application.
Aluminium/copper ..	AC. 1	D.T.D. 428	8	—	General castings.
	AC. 11A	D.T.D. 298	14	7	High-stressed components or those requiring high impact strength.
	11B	D.T.D. 304	18	4	
	11C	D.T.D. 361	21	1	
	—	3L8	7	—	General castings.
	—	4L11	7·5	1·5	,, ,,
	AC. 12	L.A.C. 10	Brinell 100/140		Light-duty pistons.
Aluminium/silicon ..	AC. 2	L.A.C. 112A	8	—	Pressure die castings.
	AC. 6	2L33	10·5	4	Castings requiring ductility.
	AC. 8	—	11	2·5	For marine work.
	AC. 9A	D.T.D. 240	11	1·5	Good corrosion resistance but lacks shock resistance.
	AC. 9B	D.T.D. 245	15·5	—	
	AC. 13	—	11	—	Pistons.
Aluminium/magnesium ..	AC. 5	D.T.D. 165	9	4	Corrosion-resistant castings.
	AC. 10	D.T.D. 300	16	7	High-tensile corrosion-resistant castings.
Aluminium/zinc	AC. 3	L.A.C. 113B	9	—	General-purpose castings.
	—	3L5	9	2	
Complex	AC. 4	D.T.D. 424	9	2	General castings.
	AC. 7	D.T.D. 133C	10	2·0	Automobile-engine castings.
	,,	D.T.D. 287	10	2·5	
	AC. 14	L. 35	14	—	High-temperature work.
	AC. 15	D.T.D. 131B	16	—	Pistons.
	,,	D.T.D. 255	18	—	

Complex Alloys

Complex alloys include those widely employed where high-duty conditions and elevated temperatures are encountered. One typical composition in this class is AC.7 (RR.50) developed by Hall and Bradbury, in conjunction with Rolls-Royce, Limited. It consists of approximately 1.5 per cent. Cu, 1.1 per cent. Fe, 1.0 per cent. Ni, 2.2 per cent. Si, 0.10 per cent. Mg and 0.2 per cent. Ti. The copper is present to produce a response to heat-treatment, and the magnesium confers age-hardening with its resultant effect on tensile strength. The nickel and iron are used to give strength at elevated temperatures, while silicon improves the fluidity for casting purposes and titanium gives grain refinement. Other alloys in this class include AC.14 (Y-alloy), AC.15 (RR.53) and AC.4 (DTD.424).[4]

Among the remaining additions, iron sometimes occurs as an undesirable impurity, and a specification may limit the amount to be present, *e.g.*, AC.10 and AC.11. In other alloys, especially those intended for internal-combustion-engine work, iron may be added to improve strength at high temperature. For this purpose, it is generally used in combination with nickel, which prevents the material becoming brittle. Manganese is sometimes added to casting alloys to improve corrosion resistance or to minimise the embrittling effects of iron on some alloys. Titanium or niobium are employed as grain refiners. Figs. 1 to 3 show typical microstructures of various aluminium alloys.

Foundry Methods

Aluminium alloys can be cast by three methods—sand, gravity or pressure die-casting; and many factors have to be considered before deciding the most suitable method for any component. If only a limited number of castings is required, then sand castings are the most economical to produce because of the cost of producing dies. However, if quantities of 500 or more

are envisaged, then in all castings of under 28 lb. finished weight, the relative costs should be investigated. Pressure die-casting is suitable for components of thin or medium section, free from undercuts. They can be produced to within ± 0.002 in. per in. or less, and give excellent reproduction for letterplates, etc. Large quantities are desirable if this method is contemplated. Gravity die-casting is very popular in this country for small or medium components. Frequently, difficulties in die design can be overcome by the use of collapsible cores or sand-core inserts. The dimensional accuracy of die-castings will depend upon several factors, including variations in section; a tolerance of ± 0.005 in. per in. is quite frequently obtained. Cast-in inserts of heavy metals are easily arranged.

Some components can be made far more easily as die-castings than by any other means, but in some cases a decision on the method of production is required. Gravity die-casting requires the manufacture of steel dies either in one's own establishment or by an outside specialist. The cost of making a die may require a long run to produce a profit. The casting may be too large to make in a die, or of unsuitable design. In this event, two alternatives arise: production by machine moulding or modification of design to adapt it to die-casting. Despite the advantages of die-casting, a very high proportion of aluminium alloy castings is made in sand. After overcoming details of manufacture, some attention should be paid to the material specified. The secondary alloys, previously mentioned, are very satisfactory for general work, although each alloy has slightly different properties. AC.4 requires rather heavy feeding and runs well, while AC.1 does not require such heavy feeding, but may give difficulties due to hot-shortness in die-casting. If cheapness is desired, secondary alloys appeal, especially since they require no heat-treatment; further, the limits for impurities are wide. An alloy such as Alpax (AC.6) has excellent characteristics which are soon lost if impurities be present; also, it requires a treatment known as "modification." Often it is found that the more desirable high-strength characteristics of some alloys are offset by poorer casting characteristics and long heat-treatments. Where strength is not of major importance, the foundryman will choose the more castable alloy.

Acknowledgement is made to H.M. Stationery Office for information contained in D.T.D. specifications and the Light Alloy Control for L.A.C. specifications. The Schedule STA/7 and all B.S.I. specifications are available from the British Standards Institution, 27, Victoria Street, London, S.W.1.

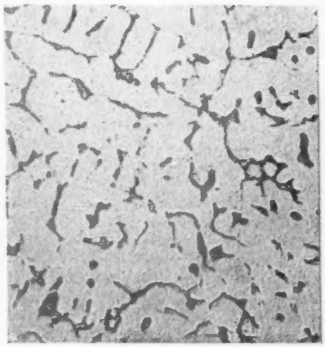


FIG. 1.—MICROSTRUCTURE OF 4L.11 CASTING (7 PER CENT. CU, 1 PER CENT. SN). THE SECOND PHASE IS A COPPER-RICH CONSTITUENT.

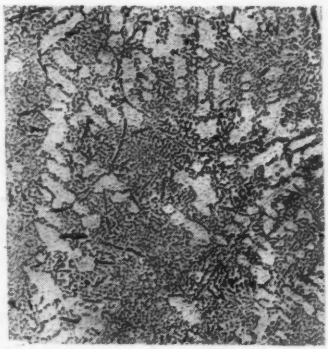


FIG. 2.—MICROSTRUCTURE OF A MODIFIED AC.6 (12 PER CENT. SI) ALLOY. THE LONG NEEDLES ARE DUE TO THE PRESENCE OF IRON AS IMPURITY.

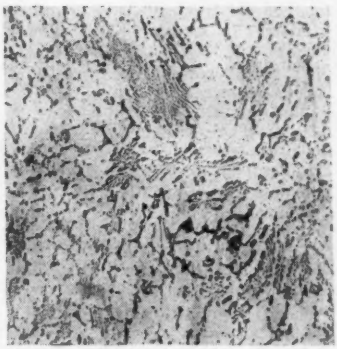


FIG. 3.—MICROSTRUCTURE OF A SAND CASTING IN AC.14B ALLOY (4 PER CENT. CU, 2 PER CENT. NI, 1.5 PER CENT. MG). THE AL-CU-NI COMPLEX IS SEEN AS A HERRING-BONE FORMATION.

REFERENCES

1 U.S.A. Patent No. 1,387,900 (1921). A. Pacz—Treatment of aluminium silicon alloys with alkali fluorides.
2 U.S.A. Patent No. 1,410,661 (1922). Edward, Frary and Churchill—Treatment of aluminium-silicon alloys with metallic sodium.
3 Brit. Patent No. 337,558 (1929). P. Pritchard and Birmingham Aluminium Casting Company, Limited—Birmabright.
4 Brit. Patent No. 521,089 (1939). P. Pritchard and Birmingham Aluminium Casting Company, Limited—A Secondary Aluminium Alloy (D.T.D. 424).
5 E. Carrington—"Aluminium Foundry Alloys," *Metal Industry*, 1946, 69 (3), 45-47, 69-72.
6 "Light Alloy Castings," May, 1944, Light Metal Founders' Association.
7 Technical Data Sheets—Alar, Limited.
8 "Which Aluminium Alloy?" F. A. Allan, *Machine Shop Magazine*, May, 1946, 7 (1), 40-42.
9 "Aluminium-alloy Casting Developments," E. G. West, Inst. of Brit. Foundrymen Paper No. 905 (1948).

Foundry Trades' Equipment and Supplies Association

At the Annual General Meeting of the Foundry Trades' Equipment and Supplies' Association, held on October 13, the following report was submitted and adopted:—

Mr. G. E. France.

Members were advised of the passing of Mr. G. E. France, of August's, Limited, on July 18. Mr. France was a past-president of the Association and one of its most active members since its inception. He was a member of the council at the time of his death. The Council feel his loss keenly and are sure that many members who knew Mr. France personally will share their sentiments.

Membership.

The number of members of the Association on December 31, 1948, was 44, and represents no change from the previous year. Two new members were admitted during the year and there were two resignations.

Accounts.

The accounts showed an excess of income over expenditure of £42 12s. 4d., increasing the balance carried forward to £85 16s. 6d. The administration expenses of the Association for the year amounted to £360 4s. 8d., which compares with £395 18s. 10d. in 1947.

Export Activity

Members will recall that the Foundry Equipment Export Group was formed during the war to comply with the Government's desire to deal with industry through bodies with unrestricted membership. The group disbanded as on October 19, 1948, and the Association adopted its functions, with the result that all members of the Association are now kept advised of export inquiries and other information regarding foreign markets.

Handbook.

During the year, copies of the handbook "British Foundry Plant and Supplies" were distributed to some 96 foreign foundries and other interested concerns.

Exhibitions.

The Association has not taken part in any exhibition since the last annual meeting, but has approved of members exhibiting individually in the Mechanical Handling Exhibition to be held in July, 1950. It is proposed that a foundry trades section should occupy the annexe at Olympia at the next Engineering and Marine Exhibition to be held in 1951.

Engineering Advisory Council.

Reports of the deliberations of the Engineering Advisory Council of the Ministry of Supply have been circulated to members, and particular attention has been given to the efforts of that body with regard to increased production efficiency. Information has been supplied to the E.A.C. regarding the steps being taken by members of F.T.E.S.A. to increase their individual efficiency and your council hope that members will continue to send the secretaries as much material of this nature as possible, in order to satisfy the departments concerned that the industry is using all avenues to improve efficiency and can be relied upon to keep alert to this necessity without governmental supervision.

Negotiations with Government Departments.

Contact has been kept with Government departments and particular mention should be made of the co-operation given by Mr. G. Munro, of the Engineering Industries Division of the Ministry of Supply, through whose good offices the Association was recently able to secure an additional allocation of steel and who is constantly supplying information of interest to the industry. The Association has been able to arrange with the Ministry for a simplified form for steel-allocation returns to take the place of all the forms previously required from the industry.

Supplies Members.

An important development since the last Annual General Meeting has been the formation of a Supplies Sub-committee to advise the council on all matters of interest to supplies members. This committee called a general meeting of supplies members on March 2, 1949, at which many matters of special interest to supplies members were discussed. The council is investigating the possibilities of being represented on the panels of any research associations whose work would deal with matters of interest to F.T.E.S.A. members. Satisfactory interviews have been held with Dr. Pearce, Director of the British Cast Iron Research Association, and, where applicable, members are to be invited to the various conferences of that association. Also, F.T.E.S.A. will be furnished with their bulletins which are issued from time to time. It is appreciated, however, that a number of our members are also members of the B.C.I.R.A., and would automatically receive this information. Interviews have been held with the British Iron and Steel Research Association and agreement has been reached whereby members interested will be invited to attend their various conferences, and we shall also be furnished with certain reports issued from time to time. It has been suggested also by both these research associations that co-operation will certainly be helpful on matters of interest to F.T.E.S.A. members.

Factories Department.

The Association has been represented on a sub-committee of the Factories Department Joint Standing Committee on Conditions in Ironfoundries, and particularly in connection with fumes arising from use of mould-driers and core-binders. Recommendations have been put forward with regard to co-operative research into gases evolved upon core baking and upon casting, and with regard to the investigation and disclosure of sources of complaints.

(Signed)

T. A. HAMMERSLEY, President.

PEAT, MARWICK, MITCHELL & COMPANY, Secretaries.

At a Council Meeting, held subsequent to the Annual General Meeting, Mr. T. A. Hammersley was re-elected President and Mr. William Aske, Vice-President.

Notes on Core Blowing Practice*

By W. Fearfield

The use of the core-blowing machine offers to management to-day a method of producing cores in large quantities, at a comparatively cheap cost, but while the operating cost is comparatively low, the initial outlay for core boxes, carriers, etc., is fairly heavy.

Successfully to produce cores on the blowing machine, much thought must be given to core-box construction and blowing-head design. If these points are carefully considered then the machine becomes a very efficient and accurate medium for core production. Given due consideration to these points, there further exists the necessity of servicing the machines. This servicing plays a very important part where high-production figures are required, and failure to service properly results in uneconomic figures. To appreciate this point one must remember that the actual blowing time is 3 to 5 seconds, and when planning core-box construction one must keep these points in mind.

Selection of Machine

The selection of the type of machine to be employed depends upon types of cores to be produced, but, even at this early stage one should envisage a multiplicity of jobs likely to be blown. The results given in this Paper are taken from experience of the vertical type of blower, but certain conditions equally hold good for horizontal types. There are not, however, any hard-and-fast rules, and each job must be considered on its merits. Before attempting to analyse the blower and its ancillaries, one must be conversant with the primary object of the core blower, that is, to fill and ram the sand in the core-box cavity as quickly as possible.

Having obtained a machine, air supply and volume should next be considered. It is important that an adequate volume of air is available, the air to be at constant pressure, and free from excessive moisture. To attempt to meet these requirements the air-supply line should not be less than intake pipe size and should be reasonably free from bends and turns. The inclusion of filter traps is also an advantage.

To obtain the necessary volume, air receivers or air-storage tanks should be situated close to the machine. The air pressure required is a frequent cause of discussion among operators; however, 90 to 120 lb. per sq. in. seems to be the most acceptable range. It is the Author's experience that smaller types of cores can be blown successfully at pressures below 90 lb. per sq. in., but the risk is ever present of soft spots, and low pressures are not recommended.

*A Winning Entry in a Short Paper Competition organised by the East Midland Branch of the Institute of British Foundrymen.

Core Sand to be Used

It may be found that in many cases the sand used on the core bench is usable and in many cases suitable, but the following considerations are noteworthy. The major requirements are: the sand should be free flowing with as low a moisture content as possible. To obtain these conditions, it is essential that the base silica sand should have been dried, so as to ensure close moisture control. The batch-type mixer appears to give the best results, but here again caution should be exercised to prevent over milling, which results in a slight toughening of the sand, which in turn reduces flowability.

Core Boxes

The selection of the core to be blown will materially affect the construction of the core box, and will be the main factor in deciding whether its construction should be of aluminium or cast iron. Much of the success in core blowing depends upon this selection of core-box construction. While a cast-iron core box is high in its resistance to wear, its disadvantage is in its weight. This disadvantage is most pronounced when large or twin, or even triple, cores are to be produced in one box. It is interesting to note that these boxes may be under the blowing head at the rate of three per minute, and in some cases more often; thus the tendency to fatigue would be high. The weight factor calls for the examination of the potentialities of light-alloy boxes.

Owing to the physical properties of aluminium, it is well known that it is less resistant to wear than is cast iron, but this can be overcome by using steel inserts at wearing points as blowing-head bushes. Aluminium boxes so treated, whether they are large or small, have good workable qualities. Before the actual master box is cast, the position of the blowing head or heads should be decided upon to enable reinforcement at this point. Much discussion revolves around the question of a flat joint or baffle type; however, whichever is used, the joints must be absolutely true, and the joint face free from any discrepancies. The nearest point of the profile of the core should be less than 1¼ in. from the outer edge of the box, as this provides a helpful seal.

Breathers

Where possible, a horizontally jointed box should be used; this provides a good seal when the core box and blowing head are brought together under pressure. In short, the core box should, as far as is practicable, be airtight. When considering the position of "breathers" in the core box, one must consider the natural path the

Production Factors Outlined

sand will take on entering the box, and breathers will require placing where necessary, to divert the path of sand around corners and recesses. The placing of breathers near the joint of the box is a useful procedure, as this helps to reduce strain at this point, but breathers must not be used indiscriminately, as it is quite easy to use too many, and soft spots will occur due to this fault.

The positioning of vents and reinforcing agents must also be given very careful consideration. The placing, for example, of a wire immediately under the blowing head may upset the whole balance of the core with disastrous results. The golden rule to the machine operator should be core-box cleanliness.

Machine Blowing Head

In considering the design of blowing head, one must appreciate the action of air on sand. When using a blowing head which has a larger surface area at the bottom than the top, and is without an agitator, the tendency is for the sand to form a tube or hole after blowing, reducing the effective blowing area. This can be overcome by recessing the blowing hole or the use of a metal insert. A more efficient method, however, is to blow different cores from different blowing holes in the same plate, in sequence. By using the latter method, it is necessary to use a blanking-off plate, but this method saves many hours in changing the blowing-head plates when blowing different types of jobs.

The selection of size, type and number of blowing holes depends entirely on the individual core to be produced. Where possible, it is preferable to use a number of small-size holes, say, $\frac{3}{8}$ to $\frac{1}{2}$ in. rather than one large hole. This method is a definite advantage where long cores with off-centre pockets are to be produced. The location of boxes under the head is done by a simple system of stops.

The distance between the sand table and blowing head should be checked frequently to ensure an even clamping pressure on the core box; failure here will soon result in wrecking the core box. While there are many other points to consider, the scope of this short Paper does not permit further comment.

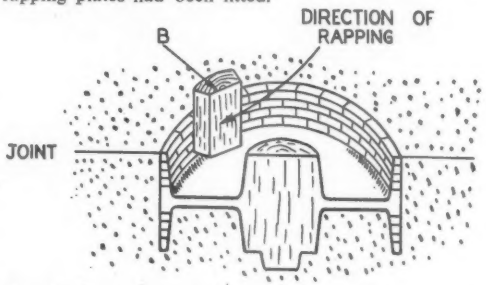
In conclusion, whilst there are no hard-and-fast rules, one may suggest the following as guides:—(1) Remove sharp corners where possible; (2) breathers should be used with discretion; (3) blowing-head holes as small as possible are recommended; (4) cleanliness is essential; (5) regular checking of machine and boxes is necessary; (6) free-flowing sand should be used, and last, but not least, (7) common sense should be used. It is the Author's opinion that all types of medium-size cores, despite their intricacies, may be blown either in one piece or in parts.

MR. S. W. AITKEN, of Hammond Lane Foundry Company, Limited, of Dublin, has recently undertaken an extensive tour of the United States and Canada.

Rapping of Patterns

By "Tramp"

The fitting of rapping plates to hand-moulded patterns should be standard practice when a number of castings are required from them, as, otherwise, after the first few moulds the pattern is badly mutilated where the moulder inserts a sharp-pointed bar into what appears to him the most convenient spot and rapps the pattern to loosen it in the mould. The choice of the most suitable spot for the rapping plate often demands much thought, as if it is placed in an unsuitable position the results may be worse than if no rapping plates had been fitted.



The illustration shows a pattern for which it is often difficult to fit rapping plates. It is a medium-thickness, rimmed V-belt pulley and when fitted into the rim, which is built-up of laminated segments, a plate soon works loose and causes a piece of the pattern to split out. In this case, rather than fitting rapping plates, the pattern-maker should supply the moulder with a piece of soft wood curved to fit the inside of the rim (as in "B"), against which he can hammer and so loosen the pattern without damaging it. The piece of wood could, of course, be moved from place to place around the rim to ensure adequate rapping in each direction.

AT A CONFERENCE of the Purchasing Officers' Association the following resolution was recommended to the Association's National Council:—

"That this Conference calls for the earliest abandonment of Government trading in raw materials in view of the fact that it has resulted in prices higher than would have been the case under normal industrial buying, and now, under devaluation, industry is forced to pay excessive prices in line with dollar values for materials which are largely produced in the sterling area, particularly important non-ferrous metals such as lead and copper. The arguments for freedom of choice and competitive prices for our raw materials now have re-doubled force in the country's present economic plight and in the vital need for exports of which imported raw materials, of necessity, form so large a part."

Institute of British Foundrymen

Some Modifications in Cupola Design

London Branch Discussion

By E. S. Renshaw and S. J. Sargood

The BRANCH-PRESIDENT (Mr. F. Arnold Wilson), introducing Mr. E. S. Renshaw and Mr. S. J. Sargood, and inviting them to present their Paper, said that Mr. Renshaw had been associated with the Ford Motor Company for more than 20 years. The Ford Company's foundry cast up to 600 tons per day, from which fact would be realised the importance of supervision on melting time on a continuous production basis. Mr. Renshaw had served on various committees and sub-committees of the Institute, particularly Sub-committee T.S.10, dealing with the basic cupola. Mr. Sargood had been associated with Mr. Renshaw for about 12 years, and had co-operated with him in his researches and everyday work.

Mr. Renshaw then presented his Paper.*

DISCUSSION

MR. B. LEVY, referring to the well-less cupola, particularly as shown in Fig. 6, asked if there was any particular difficulty in lighting up and starting it, for it seemed that the lighting up area had been reduced.

MR. SARGOOD replied that no difficulty had been experienced in that connection. In the case of the high sand bed or well-less cupola, the lighting up procedure had been precisely comparable with that previously employed, except that it was not necessary to take the more elaborate precautions previously required; the mere enlargement by the conical shape did not make any difference. This shape was now being used in conjunction with the high sand bed, and lighting up was very much quicker and easier than formerly, without prejudice at all to the temperature.

MR. G. C. PIERCE (Past Branch-President), commenting that the height of the bed was 26 in., said that that would seem to lead to great economy in coke. He asked if it did in fact reduce the amount of coke used in the charge and, if so, what was the total potential saving.

MR. SARGOOD agreed that a reduction of the coke bed meant a reduced consumption more or less corresponding to the difference in height. Of course, that applied at both ends; most of the coke below the tuyeres was eliminated, and there was also the reduction of the bed height above the tuyeres. With regard to casting temperatures, the Authors had not actually aimed at reducing the amount of coke in the charges, but it had been recorded that higher temperatures were attained with the same coke ratios; the difference was quite noticeable, being of the order of 20 to 30 deg. C.

*Printed in last week's issue.

Unaccountable Loss of Charge Materials

MR. J. N. BURNS referred to Table II and discussed the variations in the calculated CaO and SiO_2 contents of the slag and noted the increase in Al_2O_3. He wondered whether the Authors had analysed the dust which was discharged from their cupola, in order to find out whether this dust contained increased amounts of silica and lime and decreased alumina in amounts that would balance the changes shown in their slag analyses. He also asked whether the Authors had conducted tests on any of the chrome-ore refractories.

MR. RENSHAW replied that in the slag composition (including erosion product) there was 12.4 per cent. alumina, and in the slag composition (excluding erosion product) the alumina content was 15.4 per cent. These were calculated figures and the lower Al_2O_3 figure in slag, including erosion products, was, of course, due to the dilution by the additional SiO_2 from the refractory. In practice, dealing with work of this kind, one had to allow a certain latitude in the results; there was always a good deal of interpretation to be done which was not simple. He did not think they would lose alumina in the stack; lime, on the other hand, did escape with the flue gases. They had tested the deposit found on the charging equipment, and it contained about 9 or 10 per cent. of lime. The deposit in the arrangement for taking out the dust at the top of the stack did not contain as much lime as one would expect to find. They had not yet been able to make a complete balance of the products which obviously were discharged in the stack. Anything charged which was of fine grading was liable to show considerable losses. Fluorspar was used on occasions, and if the grading was too fine, the loss through the stack would probably be about 25 per cent., so that a certain amount of care had to be exercised in the sizing or grading of any fluxing materials which must be added to the charge. With regard to the chrome earths, he said they had used a chrome-magnesite lining in the basic cupola, but had found that it afforded no improvement over the stabilised dolomite brick. Indeed, he did not think that great improvement would result, because of the high iron-oxide content of the slag; he did not think one would find a refractory which would withstand that condition.

Small-output Cupolas

MR. A. R. WIZARD asked whether it was possible to apply continuous tapping to the smaller cupolas of, say, 2 tons per hr., which were normally non-continuous, and whether it was just a question of controlling the charges and watching the slag hole.

Modifications in Cupola Design

MR. RENSHAW replied that continuous tapping was inadvisable and was not advocated for very small cupolas. A satisfactory output for a continuous-tapping cupola was probably 5 tons per hour; one became involved in considerable difficulties as soon as the tonnage became less than about 3 tons per hour.

The work described in the Paper applied to cupolas of the larger tonnage which operated for long periods and was particularly applicable to the cupola/converter plant where erosion of refractories was very excessive. He had recently been informed by a converter operator that the refractory consumption in the cupola of one Tropenas plant was greater than in the converter, and he appreciated that the problem needed to be tackled with vigour.

For the small grey iron foundry, melting high-phosphorus charges, as it would do frequently over short periods, there was no necessity for the alterations discussed in the Paper; those alterations were more applicable to special cases or to high production.

Slag Control

MR. J. F. CHAMBERS, who was particularly interested in the Authors' attempts to achieve control of slag composition, said it had been stated that, irrespective of changes in the lime charge, there was a tendency to come down to uniformity of properties. The high lime charge did not increase the lime content of the slag to the extent expected, and with low lime charge there was the same tendency towards equilibrium. He asked whether, with the fully water-cooled arrangement and low refractory loss, there was any effort to run a higher-lime slag, if so, what was the effect on metal conditions, and sulphur perhaps, in the acid cupola. He also asked whether a high-lime slag in the acid cupola had a very serious erosion effect in the well, and what was the fluidity of such a slag.

MR. RENSHAW said that Mr. Sargood and himself had attempted to achieve more control over the slag composition in the acid water-cooled cupola with the acid well, and had operated with various metal and flux charges; they had found it possible to reduce the sulphur considerably. But, immediately the basicity of the slag increased, trouble in the well resulted. When the lime was in excess of the silica there would be considerable attack on the acid well and particularly (with continuous tapping) on the tapping holes, so that they rather discounted their results, and preferred to use a basic well.

Thus, while they were interested in slag composition control, they were still a long way from achieving it, though perhaps their work represented a start. It was usual, with the present cupola, to take everything for granted. Once more control was achieved over every constituent going into or coming out of the cupola, and every constituent formed in the cupola, it might be possible to achieve some control of slag composition. There were many things as yet unknown about cast iron and about the peculiar properties of molten iron, which probably would be affected by slag and slag-metal reactions. De-phosphorisation was obviously an aim and had been attempted, but it had not been established as a process.

Coke Ratio

DR. W. F. CHUBB said in particular his attention was directed to Table IV of the Paper, showing the results of experimental work. There were two considerations which had impressed him. One was the fact that in that experimental work the Authors had used a coke ratio of only 6½/1 or 7/1, despite the emphasis on the fact that coke in these days contained an exceptionally large proportion of non-combustible matter. The second consideration was that in all the experiments they had used about 13 per cent. of steel. As had been said, the experiments were of an initial character, but one would be particularly interested to know what would happen, in Mr. Renshaw's view, if the coke ratio were increased, and if the steel-scrap content were also increased to more practical proportions.

MR. RENSHAW replied that if the coke percentage were increased, the melting rate would not be increased unless a greater volume of air was used with the charge. The result of adding a higher coke charge would have been probably to bring about a greater degree of de-sulphurisation. They had found that in the basic cupola the reducing action of incandescent coke on the basic slag (reducing the iron oxide) was most important, and it could be brought about more effectively by using a higher percentage of coke; but, of course, they did not necessarily wish to use an excess of coke.

The steel scrap figure of 13 per cent. was the percentage that had to be used at present in the particular production charges with which they had been dealing, to give the carbon content required to meet the specification. All the metal with which they had been dealing had to be used in production, and they could not modify it at the time; but they would like to deal with a whole series of melts having higher steel percentages.

DR. CHUBB said he had in mind the Authors' remark that there was a certain carbon pick-up, and that on one occasion they had reduced the sulphur content to 0.034. He wondered whether the Authors had records of the conditions.

MR. RENSHAW replied that the figures were average figures over a whole melt. They could not pretend to give all the figures, but the lowest sulphur figure they had obtained in the series with the highest percentage of limestone in the charge was 0.034 per cent. He did not think there was any doubt that lower figures were achieved when using a higher percentage of coke; and when melting hypereutectic iron, he believed they could reduce the sulphur figure to 0.02 per cent. and less, using more coke to bring about the reducing conditions which would give the required de-sulphurisation. The reducing effect of coke was a most important and significant feature, and he believed that the power of incandescent coke to carry out certain reducing reactions in a cupola furnace was not appreciated. Bearing in mind the very short period

of time available, it was truly remarkable that so powerful a reducing action could be achieved in the well of a cupola; he did not think it had been recognised before, and it might have a great bearing on future work.

Early Taps

MR. A. R. PARKES, recalling the Authors' point that, by removing the well from a cupola, it was possible for the average foundry to cast metal hotter than previously, asked what happened in the morning, at the beginning of a melt. Surely, he said, some other receiver had to be heated instead of the well of the cupola, or did the Authors meet that problem by preheating the ladle?

MR. SARGOOD answered the question by referring to the operating conditions which had existed at the time they had introduced the type of well discussed in the Paper. The cupolas, he said, had two types of receivers fitted; it was almost imperative to have a receiver in front of a cupola which was always tapping. They had enclosed gas-fired receivers, and as an alternative on the larger production units they had large fixed ladles, to which burners were introduced merely for preliminary heating. So that Mr. Parkes' assumption in that connection was correct; he believed it would usually be found that for any form of continuously-tapping cupola it was necessary to use a preheated receiver of some sort, in order to ensure a good operating temperature at the commencement. Bearing in mind the conditions existing before they had introduced the type of well discussed in the Paper, the advantages of the hotter metal were immediately apparent, in that the very first metal tapped could be used readily, without any difficulty.

MR. B. LEVY asked whether, in the well-less types, there had been experience of slagging over in the tuyeres; it seemed to him that both the melting rate and "slagging-out" must be watched very carefully, for otherwise there would be distinct possibilities of slag running into the tuyeres. Again, the rate of tapping would need to be watched, and he asked the size of tapping hole and whether any difficulty had been experienced due to the tapping hole becoming choked, causing the metal to run over into the tuyeres.

MR. SARGOOD said that the greatest tonnage melted by the cupolas in question was in the neighbourhood of 22 short tons per hr. (about 20 English tons), and under those conditions it was found that a tapping hole 1½-in. dia. was sufficient to take all the metal and the slag without any difficulty whatever. Of course, there was always the prospect of an odd accident occurring; for example, a piece of lining material might become dislodged and might wedge into the hole, thereby reducing the size of the hole temporarily. If that were not noticed and corrected in time, and if melting continued at the normal rate, slag might reach the tuyeres earlier than it would in the normal well. The attendant, of course, was watching all the time; the usual indications were given at the tuyeres, and he could shut off the blast in time and clear the obstruction before any damage occurred.

When the new arrangement was first used, there had been some difficulty about blockage occurring at the beginning of a melt, but precautions had since been taken. It was mainly a matter of ensuring that the channel was clear, and normally they would use large pieces of coke in the channel to prevent anything falling down and blocking the hole. With one or two precautions of that sort, this trouble was avoided.

Carbonaceous Refractories

DR. CHUBB, recalling a reference by the Authors to a special lining of carbonaceous character which had given extraordinary results, said the claims made for it were so unusual that he would like further information. In particular, he would like to know its composition or its proprietary name—if he were not asking for too many trade secrets.

MR. RENSHAW was not sure that he would be allowed to give the proprietary name at the meeting, but he could indicate it later. But it was a similar preparation to that which was being used for the manufacture of bricks for blast furnaces. It was in ramming form, and probably consisted of coke, crushed and graded to the correct size, mixed with dehydrated tar. The Americans had reported that it was being used in blast furnace runners, and he believed it had been used similarly in this country. Where it was subjected to oxidation, probably its life would be short. When protected, it was obviously the perfect refractory, being neither acid nor basic; and it had the peculiar property of being unwetted, i.e., if there was a globule of metal on the surface it remained a globule, and one could just flick it off.

MR. J. N. BURNS asked if the Authors had tried the carbon blocks as the refractory in the cupola. Further, recalling that the Authors had shown very considerable reductions of iron oxide in the slag, he asked whether that had had any effect at all on the total iron loss over a period and, if so, to what extent the iron loss had been reduced.

MR. RENSHAW, after repeating his feeling that the carbon blocks would not be effective where there was oxidation, said that one must always try such things, of course; it was the policy in his company to try anything within reason, and to learn something from the mistakes made.

In the continuously-tapping cupola they had always found that the iron-oxide content of the slag was very low, whether the cupola was basic or acid. Probably the iron oxide was reduced more rapidly in the basic cupola because there was more lime available for the reaction; it was probably a reaction between the iron silicate and lime, and the lime could replace the FeO. Ever since they had adopted the continuous-tapping method, some 14 years ago, they always had a low iron-oxide content; so that they had not had an opportunity to check melting losses in order to determine whether there was improvement due to the low iron-oxide content. However, one could calculate it, if calculations meant anything in this instance.

MR. BURNS said he had in mind the possibilities of saving on an output of 600 tons a day.

Modifications in Cupola Design

MR. RENSHAW agreed that it was well worth while taking into consideration. For example, a 5 per cent. melting loss in the cupola on an output of 600 tons a day represented a substantial quantity of iron.

Coke Savings

MR. W. A. TURNER, introducing another economic note, said he had gathered that the Authors had achieved considerable savings in the use of refractory materials in the cupola, and he asked what one should expect the percentage saving to amount to over a period, taking account of both labour and materials. Secondly, with regard to the statement that they were getting down their metal more quickly in the initial stages of the melt, again presumably with saving of coke, he wondered whether it was fair to ask, at the present early stage of the work, how much coke (if any) per ton of metal melted one could expect to save over a period.

MR. RENSHAW said he could not give detailed figures of actual savings in refractory materials and labour, and did not think it would be wise to do so in any case; what applied to one plant did not apply to another. But one could work out the figures in each case. Obviously, if in a cupola melting 5 tons per hr. the refractory material consumption could be reduced by, say, 75 per cent., it was simple to work out the actual savings in cost. Furthermore, there was an appreciable reduction also in labour. With the water coolers there was practically no work to be done; they cleaned down the coolers, even though it almost seemed to be unnecessary. They were not certain that they were using the coolers of the correct height, and felt that perhaps they should go higher; further, there was an infinite number of designs and shapes which could be adopted, and plenty of work could be done in that direction.

An appreciable saving of coke was effected with the well-less method; Mr. Sargood had not pressed that point quite sufficiently, probably because he was too bashful, for he had done a lot of work on it in the early days, with admitted success. Obviously, one could reduce the bed height; previously, they had operated with a 60-in. bed, and it had been reduced to 26 in. What was more encouraging was that they could alter the coke ratio with more certainty. If, in a production foundry, one was melting iron for thin-section castings and wanted to reduce coke consumption, in the normal way there was always a danger; but the well-less method was probably more reliable, and one could cut down the coke charge and be quite happy about the results. There was quite an appreciable saving in the Authors' foundry.

MR. TURNER, referring to the Authors' statement, in the early part of the Paper, that the use of the continuously-tapping cupola for shift after shift could be foreseen, asked if they could say whether it would be in the near or the distant future, because the saving in capital cost on a new installation could be very appreciable.

Prospects of Continuous Operation

MR. RENSHAW said that the answer depended on what was meant by "continuous" melting or running. By means of the water-cooled cupola it would be possible within a very short time to run continuously; already the Americans were reporting that they had a certain design of water-cooled cupola in operation, that they operated it for ten consecutive days and were aiming at continuous operation for six months. Judging from the design of it, and from experience of his own work, Mr. Renshaw felt that they were still a long way from that and, indeed, he was surprised that it had worked for 10 days. But he believed that, by the combination of water cooling and the improvement of tapping hole materials such as the use of carbonaceous pastes, there were great possibilities. The longest period over which a cupola had operated continuously in his foundry was 45 hrs. At the end of that run it was found that the lining had eroded over the cooler; obviously, therefore, they must increase its height. This had been done in the Austin foundry, where Bamford had carried out some remarkable work with water cooling in his cupolas using parallel walls and extending the height of the coolers to 60 in. But one must watch all the time for any loss of temperature, for one could not afford that.

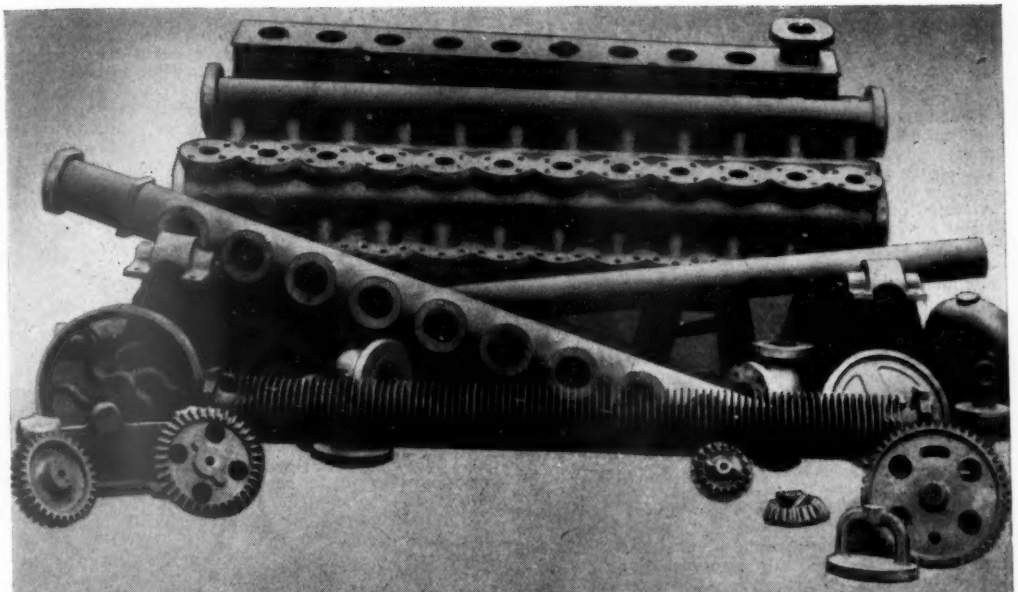
Vote of Thanks

MR. L. G. BERESFORD proposed and MR. W. WILSON seconded the proposal that a hearty vote of thanks should be accorded to the Authors. (The vote of thanks was accorded with acclamation.)

MR. RENSHAW, responding, said that work of the kind described could not possibly be carried out except with the co-operation of everybody around them in the foundry, and that co-operation was usually given very freely. Mr. Wilson, who had prepared the sketches, and Mr. McCarthy, who had carried out some of the practical work, were at the meeting, as was also Mr. Foley, one of the senior members, who had helped very much by discussing the work. To all who had assisted, the Authors were grateful.

Finally, he urged that foundrymen should "look" more to what was happening inside the cupola and see what could be done to understand the conditions which existed; it was not sufficient to stand and watch the metal tapping, and he felt that a careful study of the chemical changes taking place would reveal certain previously unsuspected reactions.

THE CLASSICALLY-DESIGNED ARCHED GATE at the entrance to the works of the Grahamston Iron Company, Limited, Falkirk, has been renovated and painted. The gateway, complete with side gates and columns, was made in the works for the Edinburgh International Exhibition of 1886. It is probably the largest cast-iron gate ever made. Its total weight is approximately 20 tons. Made in sections and fitted together, not a joint is visible to the naked eye, and altogether the gateway gives the impression of having been cast in one piece.



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The above illustration shows a group of castings made by Messrs. Goodbrand & Co. Ltd., Stalybridge, Cheshire.

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Raw Material Markets

Iron and Steel

Foundries generally are able to obtain the pig-iron they need for immediate requirements and, apart, from hematite, which is difficult to secure in the higher silicon grades, the furnaces can usually supply the grades and analyses most suitable for the type of castings required. A steady rate of production is maintained, but the demand for castings is not heavy and foundries have no difficulty in meeting requirements. In many trades, however, stocks of castings have been reduced to a minimum and will need replenishing, while there is urgent need to step up the rate of exports.

The light foundries are taking up available supplies of high-phosphorus pig-iron, production of which does not greatly exceed current needs, with the result that the furnaces have no need to add to their existing stocks. At the moment, in fact, very few of these foundries have the full permitted stock on hand. The engineering, jobbing, and speciality foundries are not excessively employed, although some of them are more heavily engaged than others. If, as is anticipated, export business shows improvement, increased demands will be made on them for castings for machinery, plant, etc. Their pig-iron requirements are forthcoming in the low- and medium-phosphorus grades and hematite, all of which are available in sufficient quantities to cover immediate needs and to provide some stock. Hematite is in fairly good supply, mostly in the lower silicon grades. Refined grades can usually be secured in the quantities and analyses desired, and shipments of these grades are being made. No other grades of pig-iron are permitted for export.

Supplies of cupola scrap are favourable and foundries have been able to augment their stocks. Foundry coke is in good supply and most consumers are accumulating stocks. Ganister and limestone are also coming forward freely, while ferro-alloys, consisting mostly of ferro-silicon and ferro-manganese, are obtainable as required. Firebricks can be procured for cupola linings and repairs in the usual sizes and grades, providing sufficient notice is given for delivery.

The re-rollers continue to obtain good outputs. There has been some restriction in the orders placed with the heavier mills and the larger sizes produced by the light mills, but this has not affected current production. The reduced demand can be attributed largely to stocks on hand at consuming points and by stockholders due to larger imports. Sheets, both black and galvanised, are in heavy demand, particularly the lighter gauges, and outputs are insufficient to meet current needs. The re-rollers have good supplies of semis. Difficulty is experienced in disposing of some sizes of prime quality steel semis from home works and there is little call for defective material, as the price differential of the latter is considered too narrow to permit of its use economically.

The demand for the larger sized joists and channels has increased, with the result that it is now impossible to obtain rolling promises before the first quarter of next year for sizes which a month or so ago were easily obtainable. Small angles have eased so much that several firms are in a position to issue forward rolling programmes for these, but the demand for very small flats, rounds, etc., still exceeds the supply. Steel plates and sheets continue to be a bottleneck, especially for the lighter gauges. With prospects of a slackening off in the demand for plates for shipbuilding, however, the position in regard to the heavier plates, ¼ in. thick and up, may become easier. Strip, wire, and rail mills continue to operate to capacity.

Non-ferrous Metals

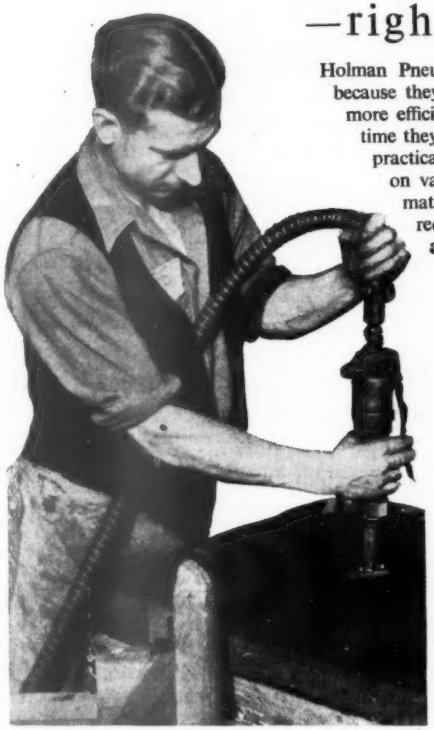
Last week saw a further fall of £4 in the price of lead to £111, this move being in line with a reduction in the United States quotation to 13¼ cents, New York. At the end of last week a figure of 13 cents was recorded for lead in the U.S. and the current prices are 13 cents for spot metal in New York and 12.80-12.85 cents, East St. Louis. As from yesterday (Wednesday) the Ministry of Supply made a further cut in its lead selling price to £105 per ton, a reduction of £6. The Ministry certainly keeps pace with changes across the Atlantic, but most people, bearing in mind the large tonnages emanating from the sterling area, will probably feel that is the least that should be done. Lead certainly looks a good deal off colour in the United States, where imported foreign lead has been selling relatively cheaply in spite of a duty of 1½ cents per lb. The fact is that consumers are taking things very quietly and waiting for a lower price before they commit themselves. In some directions it is felt that we may see lead back to 12 cents and, indeed, unless the consumers abandon their present withdrawn attitude, this may well occur.

Another non-ferrous metal which it is suggested in some circles may shortly be reduced in value is aluminium, which was £93 before devaluation and now stands at £112 in the United Kingdom. In Canada the price is 15½ cents and in the United States 17 cents. There have been rumours, too, that aluminium might be decontrolled and handed back to the producers for marketing.

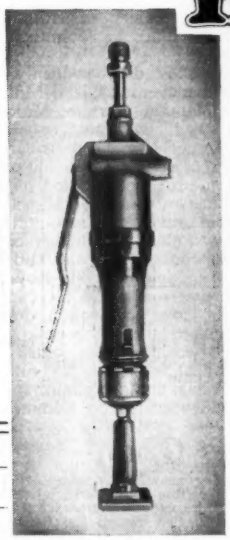
Among the non-ferrous metals, copper appears to be the strongest, and deliveries to American consumers during September are likely to make a good showing. The weakness that has been apparent in copper scrap in the United States lately has caused some head-shaking, but on Saturday last news came through of an advance of ¼ cent to 13¾ cents. True there is still a gap of approximately 4 cents between this quotation and 17⅞ cents, which is the electrolytic copper figure, but the small appreciation does suggest that buyers are showing interest and supporting the market.

No statement followed the London Metal Exchange meeting last Friday and in some directions this is being interpreted as an indication that trading in tin will not after all begin on October 25, as had been suggested in some quarters.

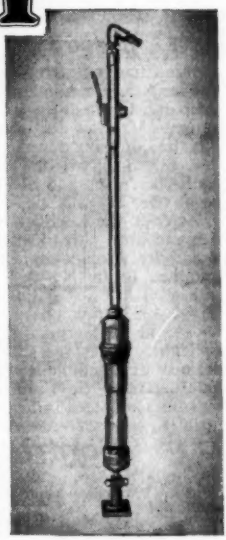
Holman Pneumatic Rammers —right on top of the job



Holman Pneumatic Rammers are welcomed by workers in many industries because they cut out the toil of packing loose materials, doing the job far more efficiently and quickly than it can be done by hand. At the same time they please managements because they save time and labour and are practically foolproof. Their special feature is their effectiveness even on varying levels of material, the piston stroke adjusting itself automatically. The range covers almost all "bench" and "floor" requirements, and various sizes and shapes of butts and peins are available. Full details and recommendations supplied on request.



Bench Type : Sizes 0 and 10



Floor Type : Sizes 20 and 30

Type	*Size*	*Length ins.*	*Weight lbs.*
Bench ...	0	17	9
Bench ...	10	23	18
Floor ...	20	48	22
Floor ...	30	47	27

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H.13

Obituary

MR. JAMES CLARKSON, late of Wilsons & Clyde Coal Company, Limited, Glasgow, died recently.

MR. DAVID FORRESTER, late of the Anderston Foundry Company, Limited, Middlesbrough, died on October 9.

MR. WILLIAM MACLEOD, late of Barclay, Curle & Company, Limited, shipbuilders and engineers, of Glasgow, died on October 6.

MR. WILFRED BAGNALL, chief metallurgist of Howell & Company, Limited, crucible-tool steel manufacturers, of Sheffield, has died at the age of 58.

MR. WALTER DREW, chairman of Harrison, McGregor & Guest, Limited, agricultural engineers, etc., of Leigh, Lancs, died suddenly on October 7, aged 76.

MR. EDGAR DAWTRY, who died on October 5, was formerly melting-shop manager of Thos. Firth & John Brown, Limited, steelmakers, of Sheffield. He was 76.

MR. JOHN EDWARD MILNER, founder and head of John E. Milner & Sons, ironfounders, of Holmfirth, Yorks, was found dead in his office at Holmfirth on October 9.

MR. CHARLES STEWART, who died suddenly on October 8, was commercial manager of Gjers, Mills & Company, Limited, pig-iron manufacturers, of Middlesbrough. Mr. Stewart, who was 57, had been associated with the company for the whole of his business career.

M. EUGENE ROY, one of the leading personalities of the French iron and steel industries, has died at the age of 65. He was vice-chairman and director-general of Aciéries de Longwy, held numerous appointments in connection with the heavy industries, and served in an advisory capacity on committees and boards appointed to further their development. M. Roy became well known as an engineer early in his career, and in 1923 took charge of coke production during the period of German sabotage of the occupation of the Ruhr. After the second world war he joined the administrative councils of Charbonnages de France and Electricité de France, and became chairman of the Iron and Steel Industry Modernisation Committee.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference E.P.D. or C.R.E. can be obtained from the Commercial Relations and Exports Department, Board of Trade, Thames House North, Millbank, London, S.W.1.

CAISTOR—Contract No. 5.—Supplying and laying about 7 miles of 5-in. and 3-in. dia. spun-iron water mains, etc., for the Rural District Council. Mr. J. H. Haiste, chartered civil engineer, 4, Queen Square, Woodhouse Lane, Leeds, 2. (Fee £3 3s., returnable.)

CHATTERIS, October 28—Contract No. 2: Provision and laying of about 1,000 yds. of 7-in. and 3-in. dia. spun-iron pipe water mains, for the Urban District Council. Elliott & Brown, consulting engineers, Stanley House, Pelham Road, Nottingham. (Fee £3 3s., returnable.)

LEICESTER, November 5—Iron and steel, ironmongery, sewerage ironwork, etc., for the City Council. The City Surveyor, 1, St. Nicholas Street, Leicester.

NEW WINDSOR—Supply of 2,532 yds. of 4-in. and 379 yds. of 6-in. Class "C" cast-iron pipes, etc., for the Borough Council. Mr. G. S. Baker, borough engineer and surveyor, 15, Alma Road, Windsor.

Company Results

(Figures for previous year in brackets.)

GLENFIELD & KENNEDY—Interim dividend of 5% (same).

LIGHTALLOYS—Final dividend of 10%, making 15% (same).

VILLIERS ENGINEERING COMPANY—Dividend of 15% (same).

JAMES H. LAMONT & COMPANY—Interim dividend of 5% (same).

BABCOCK & WILCOX—Interim dividend of 5% on increased capital (5%).

WILLIAM BEARDMORE & COMPANY—Interim dividend of 4% (same).

COLVILLES—Interim dividend of 3% (same) and special interim dividend of 5% (same).

COCHRAN & COMPANY, ANNAN—Final dividend of 7% (5%), making 9% (6½%), tax free.

WILLIAM BAYLISS—Trading profit for the year to July 30, £12,091 (£20,592, after providing £5,000 for reserve against metal stock for the period from August 3, 1947, to July 31, 1948); other income, £2,048 (£1,833); to directors' emoluments, £2,247 (£2,120); audit, £105 (same); depreciation, £580 (same); taxation, £5,200 (£13,500); net profit, £6,007 (£6,120); dividend of 12½% (same); general reserve, £1,000 (same); forward, £7,489 (£6,607).

TINSLEY ROLLING MILLS COMPANY—Trading profit for the year to June 30, £62,251 (£52,086); investment income, £90 (same); depreciation, £3,625 (£3,947); deferred repairs, £1,750 (nil); directors' emoluments, £10,662 (£8,814); audit, £184 (same); profit, before tax, £46,120 (£39,231); taxation provision not required, £1,553 (nil); brought in, £14,266 (£13,020); available balance, £61,939 (£52,251); to taxation, £26,576 (£20,750); general reserve, £10,000 (£13,000); final dividend of 12½%, making 20% (15%); forward, £20,028.

WILLIAM DOXFORD & SONS—Trading balance to June 30, £518,029 (adjusted £417,160); investments income, £18,697 (£18,443); interest, £853 (£1,620); to staff pension, £4,473 (£4,932); depreciation, £30,298 (£50,000); off investments, £24,453 (nil); directors' remuneration, £21,192 (£20,117); leaving £457,163 (£362,174); to income tax, £174,000; profits tax, £65,000—less £19,000 tax over-provision previous years—(taxation £170,000); general reserve, £50,000 (same); plant extensions and renewals reserve, nil (80,000); final dividend of 10% and bonus of 5%, making 20% (same); capital bonus issue, £50,000 (nil); forward, £147,547 (£73,634).

Training School for Retailers of Combustion Appliances

A training school for salesmen of solid-fuel combustion appliances was opened at Vauxhall Walk, Albert Embankment, London, S.E.11, last Thursday. Sponsored by the Coal Utilisation Joint Council, the project has the backing of the National Coal Board as well as of various trade organisations.

Sir John Charrington, president of the Coal Merchants' Federation of Great Britain, speaking at the opening of the school, described how the Coal Utilisation Joint Council had decided, with the co-operation of the appliance manufacturers and distributors, to organise a service and showroom scheme throughout the country. Appliances, he said, were marketed largely through the hardware trade and builders' merchants, and those appliance distributors with good showrooms and technical resources to provide the necessary advice and service were being organised into panels by the C.U.J.C. through their constituent organisations.

The overall object of the scheme is to ensure the most economic consumption of fuel by the selling of appropriate apparatus in relation to coal consumed.